POWER

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ELY C. HUTCHINSON, *Editor*

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Appreciation

I must reclaim my page for the moment to express my thanks for and appreciation of the many kindly expressions that have been received as a result of my valedictory.

I wish that I could send to the writer of each a personal note of acknowledgment and assurance of my gratitude; to tell him how much I value the nice things that he says of our past relations and his kindness in writing them.

Reading these letters, I have relived pleasant hours spent in the company of their authors, have renewed memories of some who had passed out of recent contact and have been profoundly touched that they should have so valued our association.

Not altogether alone can be one who by reading such assurances can call at will so many friends about him, can review in memory so many pleasant relationships and be cheered by such a collective demonstration of good-will and friendliness.

I shall guard and prize these testimonials as ties to activities out of which I am passing and which the writers have done so much to make enjoyable.

EDITORIALS

Coordination Needed

The habit of men to think first of the problems most directly affecting themselves is ingrained in humanity. So it is small wonder that during such a universal cataclysm as the present, our country has had thrust upon it nearly as many plans for the rebirth of prosperity as there are different interests to produce them.

Sincere and well meaning as it is, the work of the engineers is no exception. Projects for research, inquiry and statistical development now embrace the whole range of professional questions including unemployment from technological advance and their number has now increased to the point where there is need for a clearing house for engineering prosperity prescriptions.

The American Engineering Council has long been and now is actively concerned with these problems and is the logical body through which all engineering investigation into unemployment should be directed. Other engineering bodies will do well to refer their suggestions to A.E.C. before taking independent action and thereby further the cause of the whole profession.

Mercury Vapor for Process Plants

Up to the present the problem of power production in process plants has been to generate the entire factory power requirement as a byproduct of the process steam production. Since the ratio of power load to process load varies greatly in different industries, this has been easily achieved in some plants and found to be impossible in others.

In many cases, the byproduct power output has been increased by lowering the process pressure, raising the boiler pressure and by installing more efficient prime movers and auxiliaries.

All these devices increase the power obtainable from a given flow of process steam. Their adoption brings many additional plants into the group that can generate all power as a byproduct.

Recently there has been a tendency toward the acceptance by the utility companies of power generated by certain large industrials. Immediately a market is opened in this way, the desirable ratio of byproduct power generation to steam requirements increases with no limit other than economic investment cost. Such interconnection of industrial plant and utility immediately calls for high-pressure operation, unless some still more effective method of wringing power from steam can be found. This the mercury turbine may offer.

The mercury-steam plant now under construction at Schenectady by the General Electric Company is spectacular in size, design and potentialities. Financed and designed by General Electric, the plant will be operated by the New York Power and Light Corporation which will sell steam and electricity to General Electric, delivering all surplus power to outside lines.

In the mercury unit alone, 20,000 kw. will be generated. The mercury condenser, serving as a steam boiler, will generate 600,000 lb. of steam per hour, at a pressure of 400 lb. Expansion to the rather-high process pressure of 200 lb. will generate another 6,000 kw.

The amount of power obtained over the range down to 200 lb. steam pressure is impressive, but one wonders why the great possibilities for additional power generation by further expansion are not to be used.

Expansion of the full 600,000 lb. of steam to 50 lb. pressure would develop an additional 10,000 to 15,000 kw. Undoubtedly, if some processes require steam at 200 lb. pressure, it is more convenient to distribute the whole mass at this pressure and reduce locally as needed. It would seem, however, that if only one-half of the process steam could be reduced to 50 lb. before distribution the power thus recovered would pay for an extensive secondary distributing system.

Creased Vs. Plain Bends

Equations and constants for calculating the flexibility of piping systems containing bends made of plain pipe have been available for some time and are the result of many painstaking tests. Practically no information of similar nature is available for calculating flexibility when creased bends are used.

An article in this issue contains the results of tests made on creased expansion U bends which indicate this type of bend to be less flexible than bends of the same dimensions made of plain pipe. An article by W. Paul in the June 2 number of *Power* gave the results of tests made on quarter bends of plain and creased pipe which indicated greater flexibility for the creased bend. The results of tests on quarter creased bends made by E. T. Cope and E. A. Wirt of the Detroit Edison Company, when compared to the calculated flexibility of plain bends of the same dimensions, substantiate the conclusions made by W. Paul. Although these test results are not comparable, they nevertheless lead to conflict concerning the relative flexibility of creased and plain bends of the same dimensions.

The experimental data now available are evidently much too meager to permit a final conclusion. It is hoped that those interested will recognize the need of more facts and sponsor further tests.

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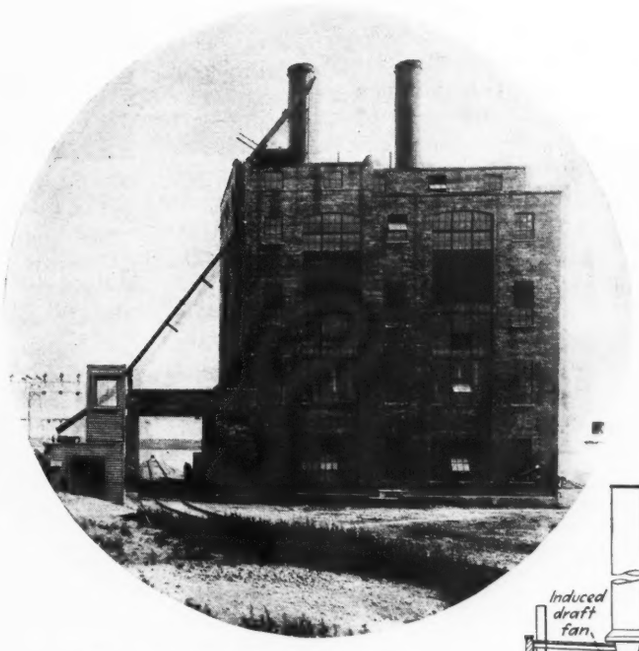
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

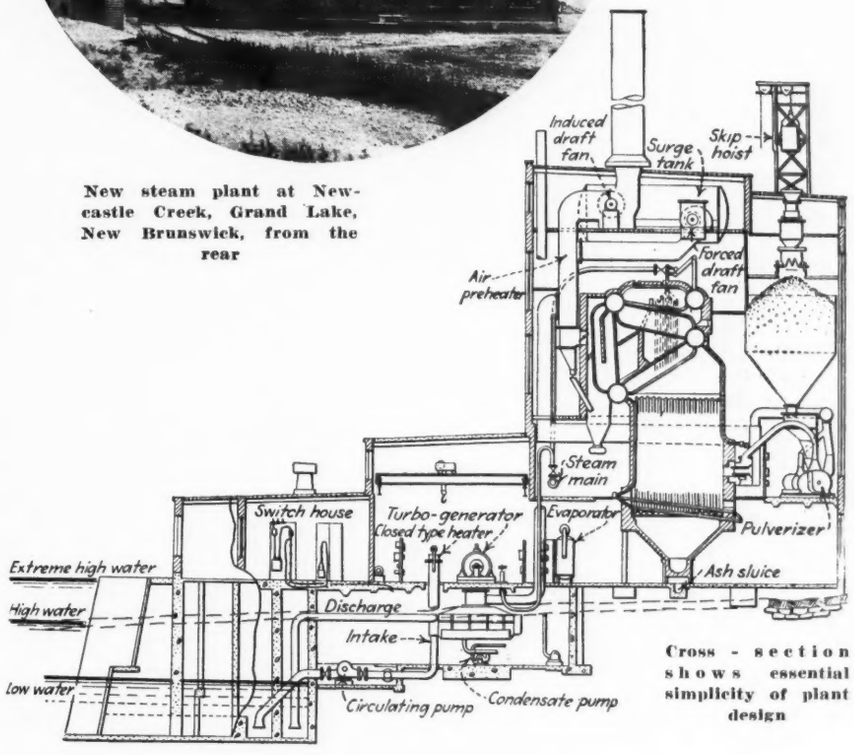
New Grand Lake Steam Plant To Correct Power Factor

By E. G. WILSON
Ottawa, Canada

THE NEW steam power station of the New Brunswick Hydro Electric Commission at Newcastle Creek on Grand Lake in New Brunswick was placed in regular operation recently. The plant is designed primarily to supply power to the city of Fredericton and the central part of the province. It is also expected to increase the efficiency of the present system by power-factor correction and to provide reserve capacity during low-water conditions at the Musquash hydro plant. Two 33,000-volt wood-pole transmission lines connect the plant with Fredericton and Marysville and are now delivering power to the Maritime Electric Company and to the Canadian Cottons, Limited, respectively. The Commission also has under construction a 66,000-volt steel-tower transmission line from this plant to Moncton, a distance of about 65 miles.



New steam plant at Newcastle Creek, Grand Lake, New Brunswick, from the rear



Cross-section shows essential simplicity of plant design

Aside from the factors of available water and coal, the station location was chosen by the Commission with the probable development of a load center near Fredericton in mind. Prior to construction of this station, the system consisted of the Musquash hydro-electric plant of 8,700-kva. capacity and a transmission line to Moncton, 100 miles east. This line is tapped at Saint John by a 4,500-kva. transformer bank and serves three additional small loads en route.

At Moncton the principal load is of an industrial character and voltage regulation here is poor. The proximity of the Saint John load to the Musquash plant, limited voltage control from the Musquash generators which otherwise could have counteracted this voltage difficulty. In addition to carrying a portion of the Moncton and Fredericton loads, the generators in the Grand Lake plant are expected to improve voltage regulation at the Moncton bus At all times the Grand Lake generators will carry wattless current up to their capacity, thereby relieving the Musquash line to a considerable extent.

The plant was designed for extension as required there being no fixed limit to the amount of power that can be developed at this site. The initial installation includes two 3,575-kva. turbo-generators and two boilers.

The boiler-room basement and turbine-room operating floor are on the same elevation, just above the ground and the railroad track level.

The steam generating equipment comprises two water-

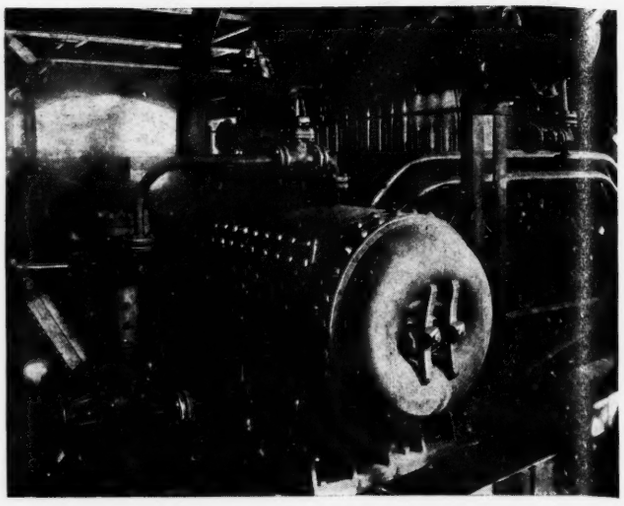
tube boilers of bent-tube type, of 6,029 sq.ft. heating surface each, with superheaters to raise the total temperature of the steam to 650 deg. F. The equipment is designed for a working steam pressure of 450 lb. per sq.in. and a maximum steaming rate of 60,000 lb. per hour per boiler.

The furnaces are water cooled, the rear- and side-wall tubes extending from the water screen to the level of the mud drum and the front-wall tubes extending from above the burners to the top of the furnace. Refractory lined, ventilated cast-iron furnace bottoms and ash hoppers receive the ash and discharge it into a sluiceway, which conveys the refuse into a pit inside the building. A centrifugal pump, specially designed, removes the ashes from the pit, discharging them into a swamp about three hundred feet from the building.

The forced-draft fans are equipped with air-inlet boxes above the boilers. By means of dampers, air for combustion may be drawn from the fan room or the boiler room below and forced through a plate-type preheater. This air at a temperature of from 400 to 500 deg. F. goes to the burners and mills. Induced-draft fans draw the gases from the boilers through the preheaters and discharge them through short steel stacks. There is sufficient natural draft to allow bringing the boilers up to pressure without the aid of the induced-draft fans.

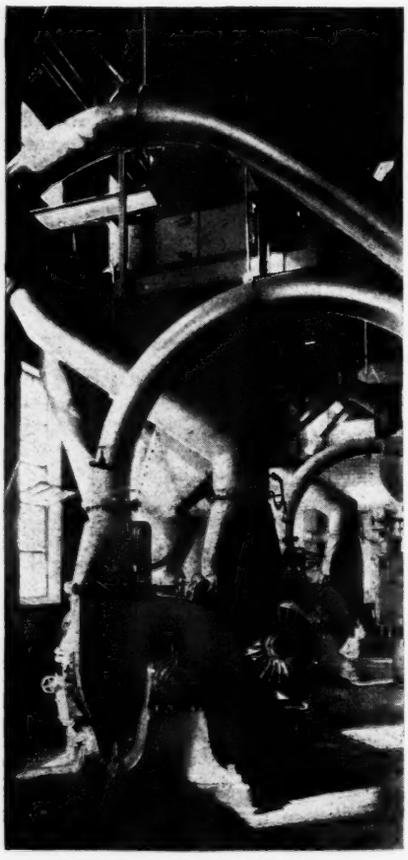
Coal is delivered in gondola type cars, discharges into a track hopper alongside the building, and is then fed by a reciprocating feeder to a crusher which reduces it to one-inch size. Both the crusher and the feeder are below the track hopper. An automatic skip hoist of 20 tons per hour capacity elevates the coal to an overhead receiving hopper, having a magnetic separator for removing tramp iron before delivering the coal to an equalizing hopper. From the equalizing hopper the coal is discharged to an automatic tram car which distributes it over the length of the bunker. The receiving hopper has a flap gate to divert coal to the magnetic separator or to a chute discharging on the ground outside the station. From this pile, coal is spread over the storage area by means of a drag-line scraper. When reclaiming this scraper returns the stored coal to the track hopper where it follows the path previously outlined. The pulverizing and burning equipment is designed to operate with coal having a maximum ash content of 20 per cent, moisture 16 per cent and sulphur 8 per cent. Two unit mills serve each boiler and are located on the operating floor.

Steam for the evaporator is bled from the turbine and the vapor from the evaporated water is carried into the shell of the condenser. Condensate from the high-pressure heater is drained into the steam space of the low-pressure heater. The drains from the latter, together with those from the evaporator, are returned to the condenser shell, first passing through a heat exchanger. Both the steam and water lines to the extraction heaters are equipped with automatic valves which will shut off the supply to the heaters in case of tube failure.



Top of boiler during construction. The superheater headers are outside the boiler roof

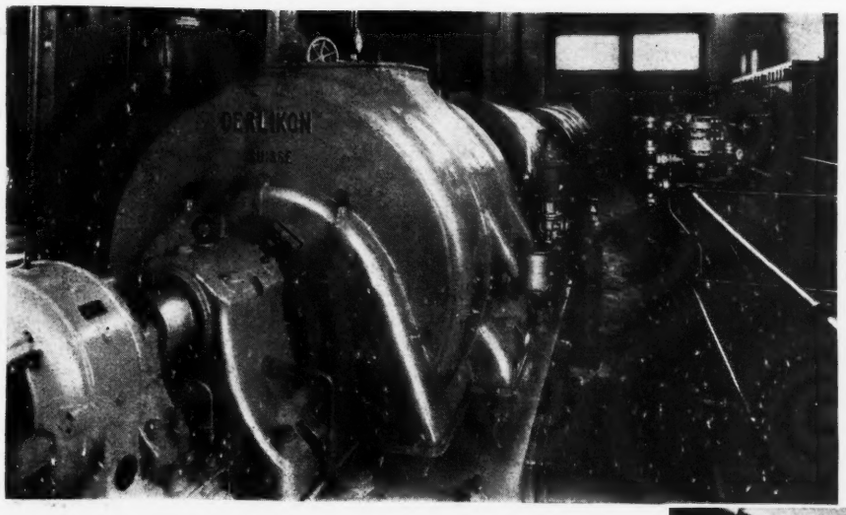
One motor-driven condensate pump is installed for each unit. A steam-turbine driven condensate pump is cross-connected so that it may be used as a spare for either unit. The condensate is pumped through a turbine oil cooler, generator air cooler, air ejector and low-pressure heater. A spare oil cooler is arranged for cooling with lake water. The boiler-feed pump placed between the high-pressure and low-pressure heaters pumps the condensate through the high-pressure heater and thence to the boilers at a maximum final temperature of 321 deg. F. To compensate for irregularities in flow, a surge tank of approximately 13,000 gal. capacity is connected on the inlet side of the low-pressure heater and floats on the line.



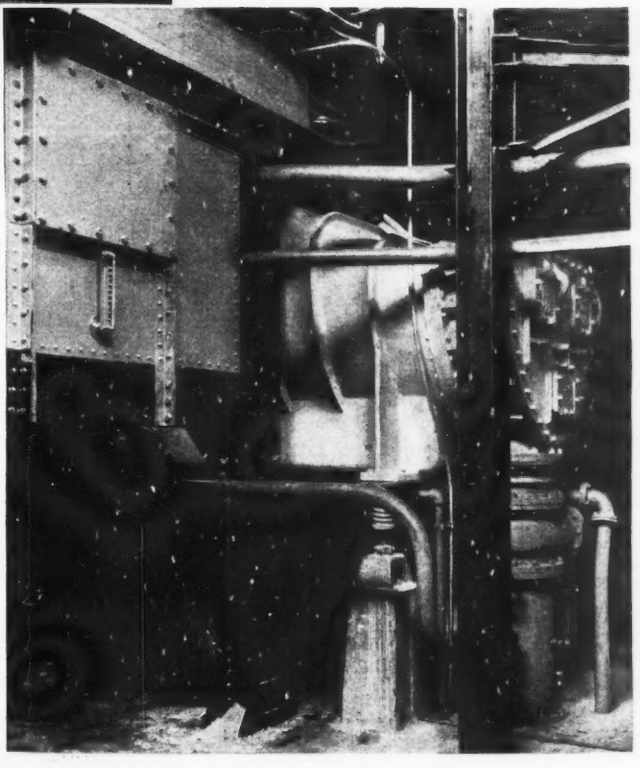
Ample light and air facilitates pulverizer operation and maintenance

There are two centrifugal boiler-feed pumps, each of sufficient capacity for handling the total flow, one pump being motor driven and the other, for use in emergency, steam driven. Each boiler has two feedwater inlets, one with a differential water-pressure regulating valve and the other with hand regulation. The valves for hand regulation are accessible at the operating floor.

Each condenser has one motor-driven centrifugal circulating pump. A steam-driven circulating pump is cross-connected to both condensers as a spare. The pump discharges into the bottom connection on the condenser. The top connection is carried to the discharge well and its outlet is submerged at all lake levels, giving a syphon effect, ensuring submerged condenser tubes at all times during operation. Condensing water flows from the lake to the intake well through a canal cut in solid rock and is discharged through a similar



This view of the turbine room shows the second generator and exciter in the left foreground and the evaporator gallery on the left



Spring-mounted condenser and circulating water inlet pipe. Generator air cooler at left

canal emptying at a distance from the intake. A 20-ton traveling crane in the turbine hall has an electric-operated hoist and a hand-operated bridge and trolley.

The initial installation comprises two 2,500-kw., 3,600-r.p.m., 0.70-power-factor turbine-generators. Each can be operated between 6,300 volts, practically zero power factor leading 3,575 kva., and 6,900 volts 0.70 power factor lagging 3,575 kva. By varying the Grand Lake generator voltage from 6,500 volts under light load to 6,900 volts at full load, it is calculated the Moncton high-tension bus voltage will vary between 65,000 and 69,000 volts, the Musquash generator voltage being held constant at all times.

The switch room was built over the condensing-water intake and discharge tunnels, using them as a foundation. Arrangement of the switch-room permits installing two more generator circuits and two future feeders, in addition to a local 6,600-volt feeder now installed. Electrically-operated, cell-mounted, 15,000-volt oil circuit-breakers are installed, having a rupturing capacity sufficient to take care of short-circuit currents, when two additional generators are installed of a combined capacity of 15,000 kva.

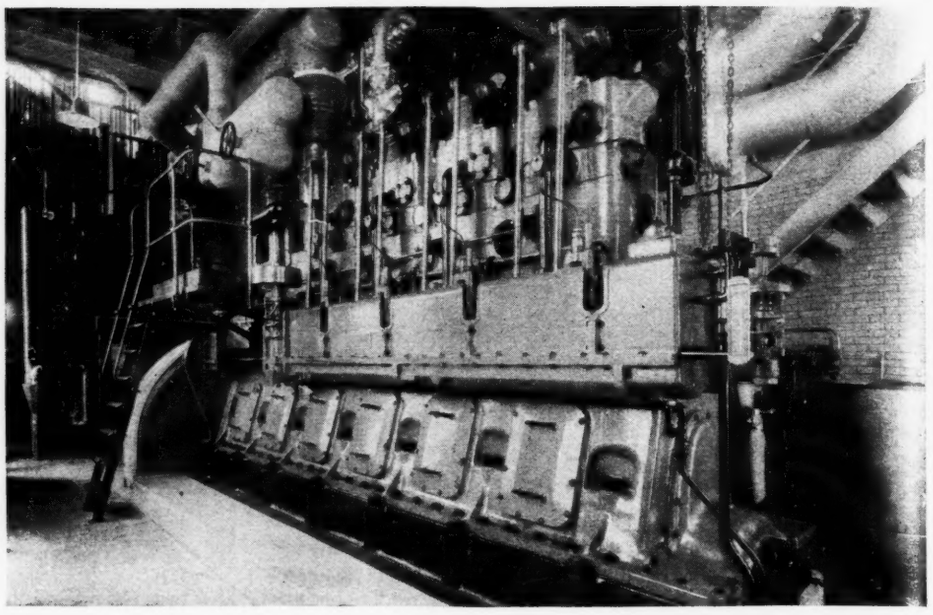
Each of the present generators is provided with differential protection and has a direct-connected main and pilot exciter. The main exciter is worked at practically residual voltage, when the generator operates at close to zero power factor leading. To avoid the risk of unstable operation of the main exciter at low-power-factor loads it was believed advisable to use a pilot exciter. Voltage regulators and current-limiting reactors were installed in each generator circuit. The latter is to reduce disturbances on the 6,600-volt bus when a short circuit occurs on a transmission line.

A bank of three 250-kva. single-phase transformers for station service is located in one end of the switch room. The present installed capacity permits operation with two transformers connected open-delta if one fails. The motor sizes allowed using 550-volt power and, to keep cost to a minimum, a safety-type switchboard was installed, having enclosed, fused safety switches mounted on steel panels. The busbars and connections are entirely enclosed but accessible through hinged doors in the rear of the board. Compensators and line starters are mounted at the motor, each with a fused safety switch to disconnect the equipment for inspection without going to the main board. The 550-volt switchboard is on the turbine floor, between this room and the boiler house, as the bulk of the load is in that neighborhood.

An emergency lighting system has been included in the design of the building and the outdoor substation. Upon failure of the alternating current supply, a number of lighting units are automatically transferred to the station-control storage battery, that has a reserve capacity for emergency of 1,500 watts at 125 volts for one hour.

All transformer secondary leads are brought out of the tanks in a pothead-type terminal. This feature, together with an underground cable system between the transformers and the 6,600-volt indoor bus structure, eliminates all outdoor low-tension bus work and supports and results in an extremely simple arrangement.

The new power station was designed by and built under the supervision of United Engineers and Constructors of Canada Limited. Acting for the company were R. M. Henderson, president; W. H. Jones, supervising engineer; Donald Drysdale, superintendent of construction. The entire period for design and construction was 11 months, including the winter. Ground was broken four weeks after the beginning of plans and construction was held closely to schedule throughout.



The ammonia cylinders are at the flywheel end of the diesel-compressor unit

DIESEL-AMMONIA COMPRESSOR UNIT

Installed at Long Beach Ice Plant

Other features of this new Knickerbocker ice plant are automatic alarms and engine stops, pendulum can-water air agitating system and high-speed crane for turning over ice cans

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INCREASE in the demand for ice by residents of Long Beach, L. I., during the past few years brought the ice sales of the Knickerbocker Ice Company to such volume as to warrant the construction of an ice plant in that town. Previously the company distributed ice from a storage plant supplied by trucks from a neighboring town.

The new plant is of 60 tons' rated capacity and has been built around the existing delivery room. It contains several features new to ice plant construction, the most outstanding being a combined diesel-ammonia compressor. Other features are automatic alarms, a high-speed device on the crane that handles the ice cans and pendulum can-water agitation.

Diesel-engine drive for ammonia compressors has been standard with this company for a number of years, the more recent installations being direct-connected units. The size of the plant at Long Island indicated a four-cylinder diesel to be best suited to drive the compressor, but some apprehension was felt concerning vibration with this type, because the foundation had to be placed on sandy soil. As a result, the engine builder developed a combined diesel-compressor.

The diesel engine is a four-cylinder 15 x 18-in. unit rated 235 hp. at 220 r.p.m. Virtually a standard six-cylinder engine was employed, with the exception that two of the diesel cylinders were removed, being replaced by the ammonia compressor cylinders. Thus the complete unit is self-contained, there being only one standard engine bedplate and frame and one crankshaft, without intervening couplings for the unit. Thus, in effect a six cylinder unit was secured which eliminated the expected vibration trouble and in addition had the advantage of occupying less floor space.

Fuel oil of 28 to 31 deg. Baumé specific gravity is used, which may be preheated to 110 deg. during cold weather by hot water from the exhaust jacket. Fuel oil is stored in a 10,000-gal. tank, the daily oil supply being pumped to an overhead tank from which it flows to the engine by gravity. The daily supply tank is provided with a float-controlled switch that automatically starts the fuel-transfer pump when the level in the tank becomes too low.

Forced-feed lubrication is by means of a geared-type pump directly connected to the engine crankshaft, the pump discharging into a wall tank. In the event of the lubricating oil level being reduced below a set limit,

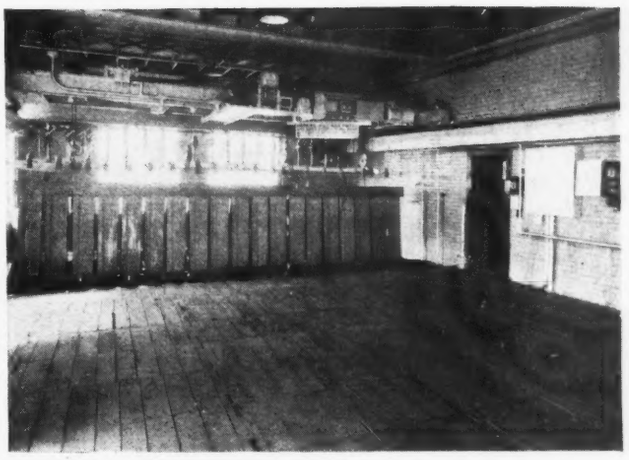
the engine is automatically stopped, but prior thereto a float switch in the wall tank signals an alarm that a low lubricating-oil level is being approached.

Equipment for reclaiming the diesel engine lubricating oil is used once a week. Oil, water and oilite are heated in a container to 180 deg. by a 2,000-watt heater and agitated with air. After this treatment the mixture is drawn off to a settling tank.

An overspeed trip device operates to hold open the exhaust valves should the engine speed become excessive. Additional protection is given by a bell alarm which operates when the ammonia head pressure reaches 175 lb., a Klaxon horn sounds at 200 lb. and the fuel supply to the engine is shut off when the head pressure reaches 220 lb. Another alarm operates in case the pump supplying condenser and jacket cooling water stops. These alarms make it possible for one man to operate the plant during the night shift and for the engineer to attend to many details during the day that would be impossible without them. Each cylinder is equipped with a thermometer for indicating exhaust-gas temperature, and an additional set indicates water-jacket temperature.

The foundations received special treatment because of the nature of the supporting soil, which is made ground. The engine foundations rest on piling, cork being introduced to isolate the engine foundation from the main concrete pier. Notwithstanding the relatively unstable nature of the soil, no vibration has been experienced.

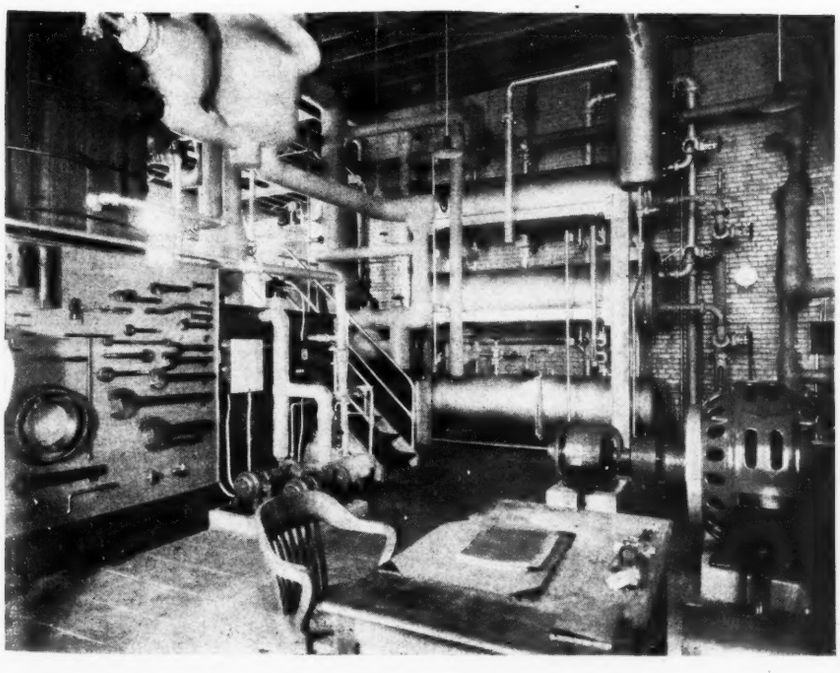
The two single-acting ammonia cylinders, the pistons of which are actuated from the same crankshaft as the diesel end of the unit, are 10 in. diameter x 18 in. stroke. They are of the multiple-effect type. The suction pressure generated in the brine coolers is taken in through a suction valve on the liner in the cylinder. The gas pressure generated by precooling the water and by the cooling of the liquid ammonia is taken in through a separate suction line to multiple-effect ports uncovered at the end of the suction stroke. The connections have valves so located that the multiple effect can be used on either one or both cylinders, and if the cylinder is not operating under multiple effect the coils can be used as a booster to the main suction valve. This insures complete filling of the cylinder.



Ice cans are ready for dumping. Air connections to agitators may be seen at the right

The piston rods operate in a chamber entirely isolated from the suction gas, so that no changes of temperature on the piston rods occur, thus giving perfect application to the packing. There are no valves in the pistons, the valves being in the heads and easily reached for inspection and maintenance. The compressor cylinders are lubricated by injecting oil at three points in the cylinders approximately 120 deg. apart.

Condenser and jacket cooling water is supplied from a well by a vertical pump of 300 g.p.m. capacity. The temperature of the water is about 57 deg. and permits a normal head pressure of 115 lb. After passing through an oil separator the ammonia is condensed in two 12-pass shell-and-tube condensers each containing 483 sq.ft. of condensing surface. The ammonia liquor is first delivered from the receiver to a high-pressure surge tank, where the pressure is dropped to about 40 lb. From this surge tank liquor is fed by hand to a forecooler of the flooded-trunk type containing 444 ft. of 1¼-in. diameter pipe. The high-pressure suction is taken off from the top of this surge tank.



The forecooler is on the left, the condensers and ammonia receiver along the back wall and the belt driven generator at the right

The main flow of liquor, now at about 27 deg., is from the high-pressure surge tank to a low-pressure surge tank which feeds two brine coolers located at opposite ends of the brine tank. The low-pressure suction at 17 lb. per square inch is taken from the top of the low-pressure surge tank. The surge tanks act to prevent liquid carry-over into the suction lines, which are insulated throughout their lengths.

Each brine cooler contains 240 two-inch diameter tubes 12 ft. 6½ in. long. Brine is circulated through the coolers by 20-in. diameter propellers operated at 175 r.p.m. The brine tank is baffled so that the temperature of the brine is practically uniform at 10 degrees.

Water for ice making is taken from the city water main and after chemical treatment is delivered to a settling tank. After settling it is passed through a quartz filter and then cooled

to 40 deg. in the forecooler before delivery to the can-filling tank.

The brine tank holds 32 rows of ice cans, with 19 cans in each row. Mechanical-pendulum can-water air agitation is installed. It consists of $\frac{1}{8}$ in. pipe through which air at $1\frac{1}{2}$ lb. pressure is discharged. The $\frac{1}{8}$-in. pipe is swung back and forth like a pendulum by a shaft that extends the length of the tank room. About $\frac{1}{2}$ cu.ft. of air per minute is supplied to each can by one of two centrifugal blowers operating at 3,600 r.p.m. Cores of about one gallon are pulled and the top of the ice is washed off when the agitators are removed.

It takes about 32 hr. to freeze a row of cans, and since there are 32 rows, a row is pulled about every hour. The electric crane that handles the ice cans is equipped with a special high-speed lowering device, used when the cans are being turned over to dump the ice out. The purpose of the high speed is to dump the ice out of the can before it has an opportunity to freeze to the can and stick, making it necessary to use a bar to loosen it.

Liquid ammonia for cooling the ice-storage room, which is kept at about 26 deg., is taken from the liquid line shortly after the receiver and expanded through coils in the storage room ceiling. Because of the highly seasonal demand for ice at Long Beach, a Long Island summer resort, the ice plant will be shut down during the winter. A 2-ton automatic machine keeps the storage room cold during the time the main plant is shut down.

Electric energy for driving the various plant auxiliaries is furnished by a generator belt-driven from the engine flywheel at 720 r.p.m. The generator is rated at 70 kv. and 240 volts.

The plant was designed and erected according to specifications prepared by the enginering department of the Knickerbocker Ice Company. Diesel engine and ammonia compressor were furnished and installed by I. P. Morris & De La Vergne, Inc. The ammonia evaporating and condensing system was furnished and installed by the York Ice Machinery Corporation. General contract for the building which houses the equipment was awarded to the contracting firm of Kuhn, Smith & Harris, Inc. Ice cans, can grids which tie a full row of cans together, and the mechanical pendulum can-water air-agitating system were furnished by the Knickerbocker Stamping Company. The condenser water well pump was furnished by the Sterling Pump Company, and pipe covering on all the low-temperature lines was furnished and installed by the Robert A. Keasbey Company.

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Pumped Storage Hydro-Electric Plants in Europe

By W. E. WINKLER
Zurich, Switzerland

PUMPED-STORAGE hydro-electric plants can be divided into low- medium- and high-head installations. For low-head installations large quantities of water have to be provided, a condition that is difficult to satisfy economically for large capacity. Favorable conditions for such an installation are rarely found, and for this reason low- and medium-head storage plants are not economical due to the large investment required.

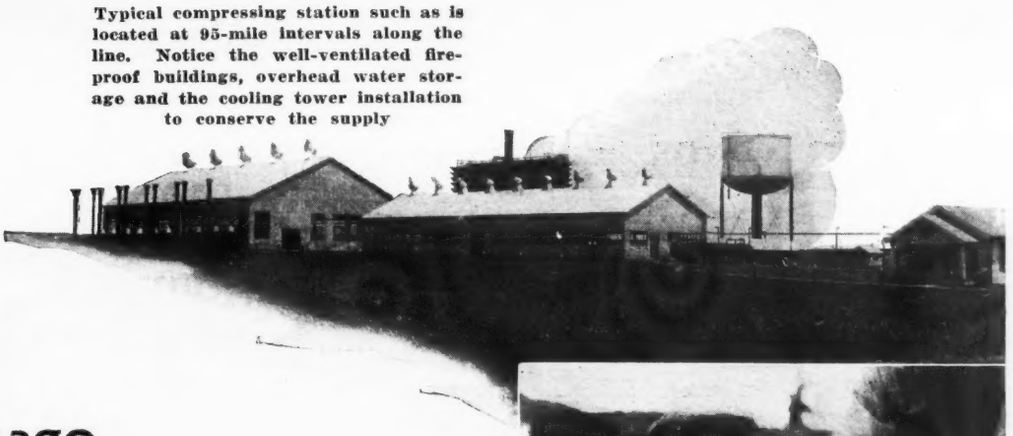
For high-head plants of this type conditions are different. They can be designed for a higher over-all efficiency than can the low- and medium-head developments, with a corresponding gain in energy output. On account of the high head comparatively small quantities of water have to be pumped, requiring a small storage basin. Power for pumping the water into the reservoir is obtained during off-peak and flood periods. At least part of the pumping power is generally supplied by low-head plants without storage. The water is pumped into the reservoirs by using low-cost or waste power, and is used to supply the high-cost peak load.

In the earlier pumped-storage installations the over-all efficiency was about 50 per cent. Today, with pump efficiencies up to 87 per cent and turbine efficiencies of over 90 per cent, the over-all efficiency of these plants, including transformers, power for station use and operating losses, is 76 per cent or higher.

Although calculations have proved that only high-head plants are economical for pumped storage, in certain cases heads as low as about 65 ft. can be used advantageously. In Germany, particualrly, there are many large installations of pumped-storage plants to carry the peak load on power systems. The table gives a list of important pumped-storage plants in Europe, along with data on the turbines and centrifugal pumps installed. There are other less important plants that have not been mentioned.

IMPORTANT PUMPED-STORAGE HYDRO PLANTS IN EUROPE

	No. of Turbines	No. of Pumps	Eff. Head in Feet on Turbine	Max. Head in Feet on Pumps	Turbine Hp.	Pump Hp.	Total Turbine Hp.	Total Pump Hp.	Position of Shaft	Year Started
Schaffhausen, Switzerland	2	2	425	528	1,000	1,000	2,000	2,000	Horiz.	1909
Funghera, Italy	2	1	450	470	4,000	4,000	8,000	4,000	Horiz.	1910
Fridingen, Germany	3	3	525	580	750	620	2,250	1,860	Horiz.	1924
Schwarzenbach, Germany	1	1	1,230	595	27,500	9,900	27,500	9,900	Horiz.	1925
Tremorgio, Switzerland	1	1	2,730	3,030	15,000	13,600	15,000	13,600	Horiz.	1926
Reutlingen, Germany	1	1	305	440	2,000	1,500	2,900	2,300	Horiz.	1926
	2	1	22	440	900	800	.....	.....	.....	.....
Zweribach, Germany	1	1	1,510	1,640	800	1,050	800	1,050	Horiz.	1926
	..	1	.....	.....	.....	2,100	.....	.....	.....	.....
Münster, Alsace	1	1	1,300	1,350	2,100	560	2,100	3,030	Horiz.	1926
	..	2	.....	.....	.....	370	.....	.....	.....	.....
Viverone, Italy	4	4	475	490	1,250	1,250	9,250	9,750	Horiz.	1920
	..	..	.....	.....	2,000	2,000	.....	.....	.....	....
	..	..	.....	.....	2,000	2,000	.....	.....	.....	....
	..	..	.....	.....	4,000	4,500	.....	.....	.....	.....
Belleville, Savoy	..	2	.....	1,700	.....	5,000	.....	10,000	Horiz.	1925
Wäggital, Switzerland	4	4	855	880	22,500	5,100	90,000	20,400	Vert.	1925
Hemfurth II, Germany	3	2	135	123	7,860	8,350	23,580	16,700	Vert.	1928
Leitzach, Germany	1	2	410	430	11,000	8,000	11,000	16,000	T. hor. P. ver.	1929
Niederwartha, Germany	4	4	465	485	30,000	27,000	120,000	108,000	Horiz.	1930
Herdecke, Germany	4	3	510	482	48,500	36,100	194,000	108,300	Horiz.	1930
Schwarzenbach, Germany	1	1	1,230	595	35,000	18,850	35,000	18,850	Horiz.	1930
Bringhausen, Germany	4	4	940	990	40,000	30,000	160,000	120,000	Hgriz.	Under Const.
Schluchsee, Germany	4	4	600	485	46,000	26,300	184,000	105,200	Vert.	1931
Bleilochsperre, Germany	4	2	190	170	29,500	18,800	118,000	37,600	Horiz.	Under Const.
Lac Noir, Alsace	4	4	385	390	27,000	25,300	108,900	95,200	Vert.	Under Const.



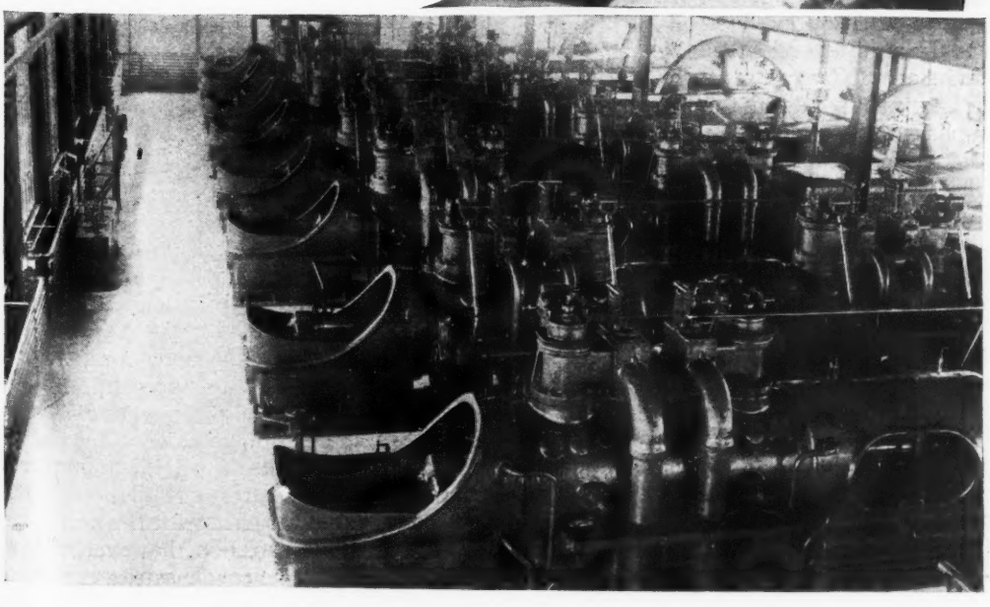
Typical compressing station such as is located at 95-mile intervals along the line. Notice the well-ventilated fireproof buildings, overhead water storage and the cooling tower installation to conserve the supply

Along the Texas-Chicago Natural-Gas Line

THE accompanying photographs are typical views taken during the construction of the 950-mile 24-in. natural-gas line from the Amarillo gas fields in Texas to Chicago. This line has just been completed, as was announced in *Power*, Sept. 29. Under an operating pressure of 600 lb., a capacity in excess of 200,000,000 cu.ft. per day is anticipated. Use of this gas in Chicago is being delayed pending the consideration of a new rate schedule by the Illinois Commerce Commission. When the load increases sufficiently a second 24-in. line will be built. A dry-gas gasoline absorption plant has been erected at the Fritch station, which will handle 200,000,000 cu.ft. daily.

The coupling mixture is gone over with a brush after it has been poured at a joint in the 24-in. line

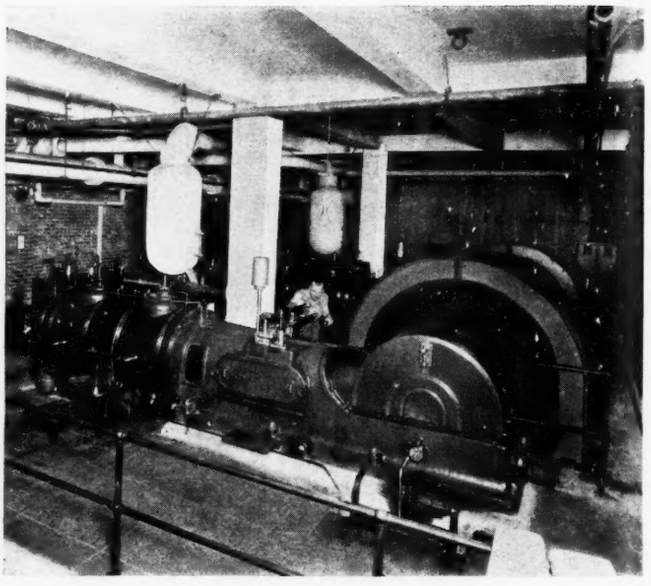
Before being placed in the ground the welded pipe line is given an enamel spray and then covered with felt paper. In the photograph the latter operation is in process



The main compressor units are duplex-tandem, four-cylinder double-acting engines with 24x36-in. cylinders, rated at 1,250 hp., driving duplex single-stage compressor cylinders. The station at Fritch, Texas, contains twelve of these units, and the other nine stations five each

Steam Cylinder Lubrication of Modern High-Pressure Engines

By ALLEN F. BREWER



Lubrication of steam cylinders frequently requires consideration of the effect of high pressure and superheated steam upon the lubricant, as well as the effect of the lubricant in the condensate. Economy dictates the use of the superheated high-pressure steam and the effective utilization of the heat contained in the exhaust or condensate. To render the exhaust more adaptable for feed water or process-heating purposes, oil separators or grease extractors are coming into general use in factory plants employing reciprocating steam engines.

TO MEET modern operating conditions every care should be given to selection of steam cylinder oils for such service. Primarily any such oil should be able to withstand the prevailing steam temperatures. The higher the lubricant's flash and fire points the more effectively will this be accomplished. It is most important to remember, however, that under modern conditions of pressure and superheat the steam temperatures may sometimes be higher than the flash and fire points of certain types of cylinder oils. But if the viscosity or body is sufficient to insure adequate film strength on the cylinder walls and valve chest surfaces, to prevent metallic contact between the opposing surfaces of the pistons and valves, dependable lubrication will result.

Film strength, while a function of viscosity, is also dependent to some extent upon the compound, or fixed oil, content. This is in part a reason why so many cylinder oils for high-pressure service are compounded products. Theoretically the absence of saturated-steam conditions would preclude the use of any animal-grease compound, for there would seem to be no necessity for emulsification. On the other hand, the possibility of a certain amount of condensation, plus the proved advantage of fixed, or fatty, oils as an adjunct to film strength, have been sufficient reason for compounding such oils today.

There is a disadvantage to this procedure, however, where oil-free condensate may be desirable, for the presence of compound renders the resultant oil more intimately retained by the exhaust.

And yet, irrespective of the conditions within the cylinders and valve chests of high-pressure or superheated engines, plant operators and lubricating engineers generally prefer to use a compounded cylinder oil because of the added protection which it affords. It is the contention of certain adherents of the oil separator that such a device will prove its ability regardless of the original nature of the oil used.

In regard to resistance to the prevailing temperatures, it may often be desirable for a steam cylinder oil for high-pressure or superheat service to be sufficiently nonvolatile to resist, if possible, a too rapid vaporization under the temperatures involved. This property is affected by both the flash point and the viscosity.

On the other hand, if complete vaporization occurs, the possibility of oil accumulations and development of carbon deposits in the engine itself will be minimized. This can best be controlled by careful regulation of the lubricators based on actual experience with the particular engines concerned. Such vaporization, however, means the ultimate presence of oil in the condensate, a condition

which may require consideration, dependent upon the manner in which the heat of the latter is to be utilized and the efficiency of the oil separators or grease extractors.

Carbonization and Deposits

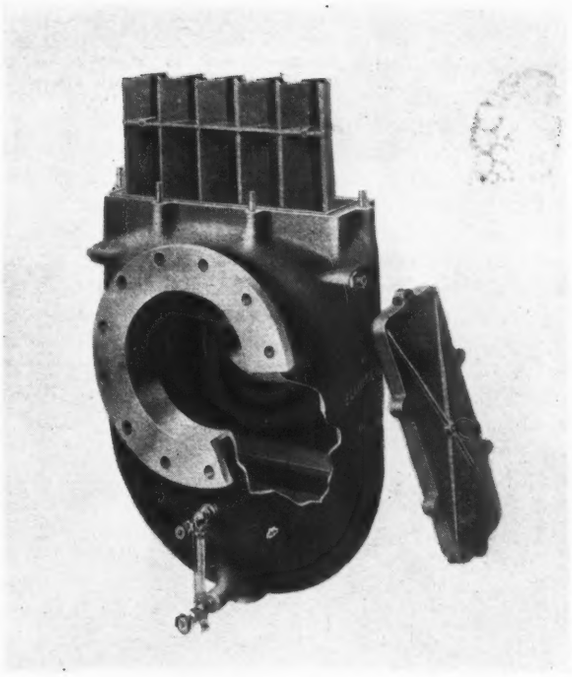
Film strength is not the only objective. Elimination of carbon deposits must also be considered, as stated above. The extent to which these may develop will be dependent upon the volatility, the flash point, the amount of air present and the degree to which the oil has been refined. Filtration of the original stock has been proved to be advantageous in the reduction of the amount of carbon deposited, just as high flash point, in precluding excessive volatility will enable the oil to retain more nearly its intended chemical structure.

In general, however, presuming that the oil has been carefully selected, and is of such characteristics as to meet the operating conditions, deposits in steam cylinders or valve chests will be an indication of improper operation, such as the use of too much oil, or the presence of air. The normal lubricating requirements of a high-pressure superheated engine will be less than those of an engine running on saturated steam, for development and maintenance of the necessary lubricating films will be more readily accomplished if the oil is of the right viscosity and has a sufficiently high flash point. Often this point is overlooked, by many operators, and the rate of oil feed increased as a matter of insurance.

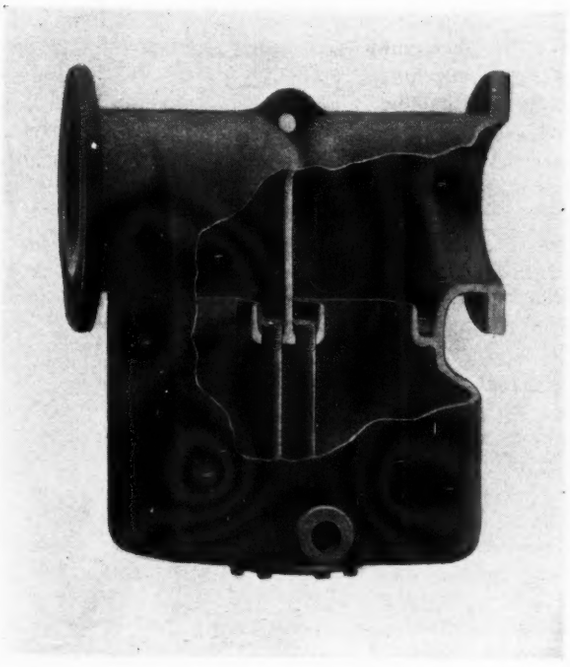
Frequently this excess oil may not be harmful. But if the presence of oil in the condensate may be objectionable and effective means of separation are not provided, the effect of such oil on process heating surfaces or on the boiler tubes may be decidedly detrimental, especially if the condensate is returned through open feed-water heaters.

Determination of Rate of Oil Feed

There is always a question as to just what the rate of oil feed should be. Normally it will be inadvisable to state hard and fast rules in this regard. Over-lubrication should always be scrupulously avoided. Often such an occurrence will be the result of negligence or lack of appreciation of the actual lubricating requirements of any particular engine. To state arbitrarily that the rate of oil feed should be four, eight or twelve drops per minute per cylinder would be unwise. Too many variables are normally involved, dependent upon the type of lubricator, steam pressure, velocity, size of cylinders and viscosity of the oil. In general the heavier the oil the larger the drops delivered by the lubricator, especially if the latter is of the hydrostatic type. On the other hand, since steam temperature increases with the pressure in the modern high pressure, superheated engine, the effect of such temperatures will be to reduce the viscosity of the oil to render it more conducive to flow through the lubricator. This should also facilitate atomization and subsequent distribution by the steam.



Horizontal separator with baffles



A straight run separator

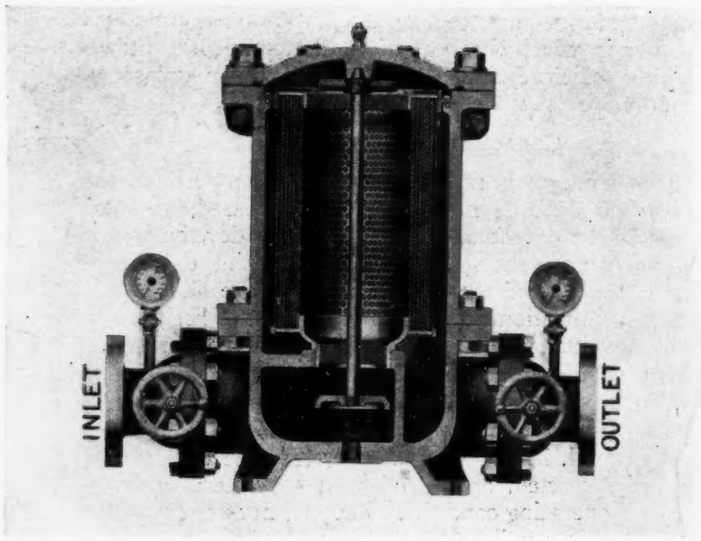
In consequence, the necessity for study of individual engine conditions can be readily appreciated. Effective lubrication can be determined by: the condition of the wearing surfaces, and observation of the exhaust.

The former is in reality the best test of the extent to which any particular oil is giving proper lubrication. To obtain accurate data any such test should be carried on for a period of several weeks, keeping accurate record of the rate and amount of oil feed and the condition of the exhaust. At the end of the test period the cylinder heads, as well as valve chest covers, should be removed immediately and the interior studied before any of the oil evaporates.

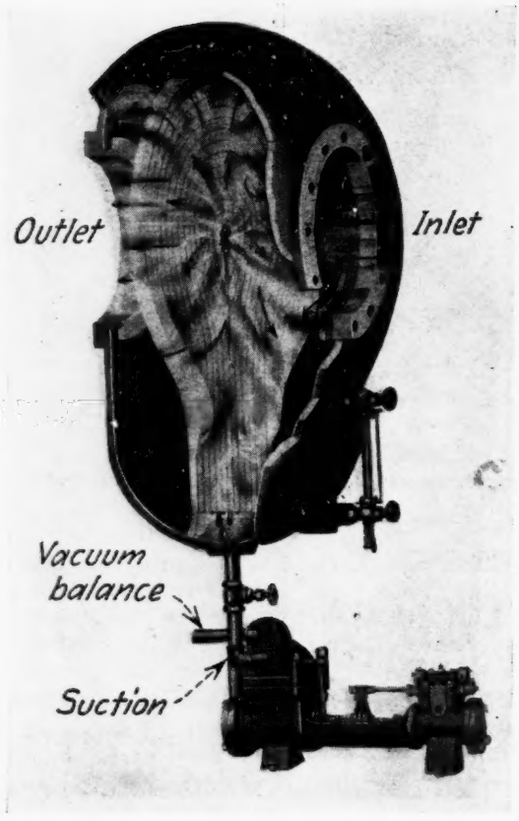
If subsequent inspection shows a film of oil on the fixed wearing surfaces that will penetrate and stain three or four thicknesses of cigarette paper, effective lubrication may be assumed, especially of the surfaces of the cylinder walls appear highly polished beneath this film of lubricant, varying in color from bright iron-white to a steel-blue.

Should the walls be dry, dull in appearance, rusty, or at all rough, insufficient lubrication or use of an unsuitable grade of oil is indicated. In turn, should the stains

Right—Device to remove oil from feed water by cloth filters



Below—Separator for use on vacuum steam lines



developed on cigarette paper be blackish and streaked or mottled, it will be an indication that the oil has carbonized. Insufficient lubrication may also be indicated by sticking of valves, improper action of corliss engine dashpots or emanation of groaning sounds from cylinders.

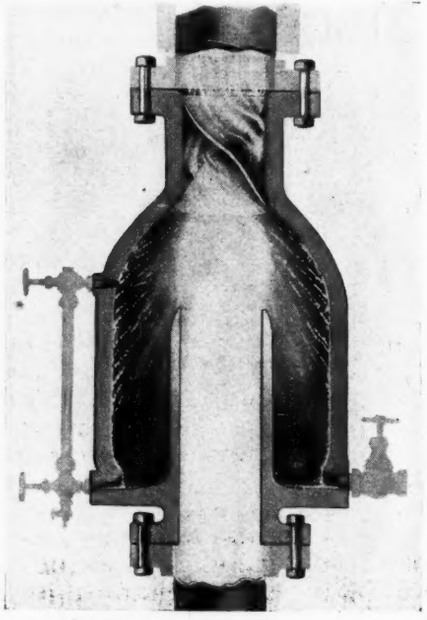
The appearance of the exhaust is of particular value as an indication of over-lubrication. The exhaust steam should be milky or somewhat opalescent, being to an extent like water which contains more or less air.

Normally there should be a negligible amount of free oil in evidence, for by virtue of the compound content as well as the degree of original atomization, in a properly lubricated engine, the oil should be completely emulsified at the time of exhaust. Should the steam at this time show any visible oil content in the form of actual drops it will be indicative of over-lubrication. For this reason the exhaust should be periodically observed during any test as mentioned above.

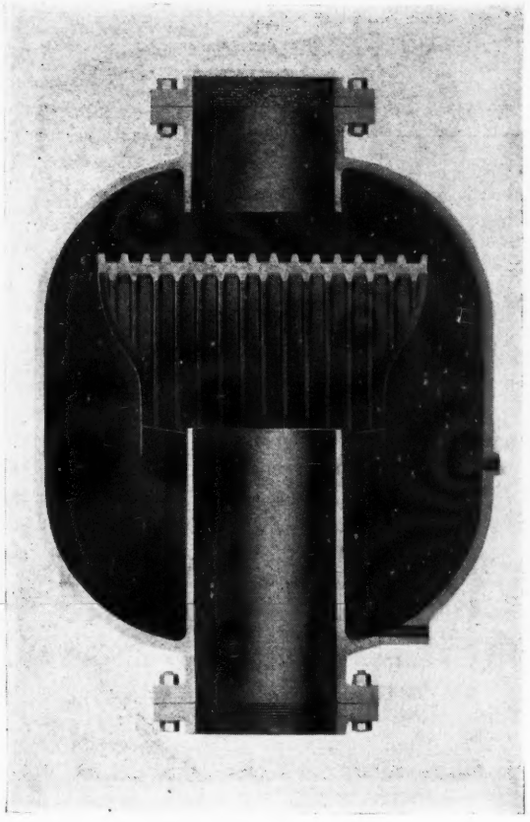
Excessive lubrication can also be noted at the inspection period by observing whether oil pools have accumulated in the counterbores or lower parts of the cylinders. The condition of the piston rod is also an indication. If this latter carries an oil film during operation it is a sign of adequate lubrication.

While exceptionally high viscosity cylinder oils are not essential for superheated steam conditions, where high pressure is involved, coupled with superheat, an increase in viscosity will be advisable to avoid premature vaporization with the possibility of inadequate lubrication. In this regard it must be borne in mind that the flash and fire points of cylinder oils in general will vary directly with the viscosity.

It must be borne in mind, however, that the nature of the stock, or base, of a cylinder oil will have a decided effect upon the adhesiveness of the finished product. Where filtered stocks are involved this property will be lower than in the case of steam-refined stocks, for in the process of filtration certain of the heavier, more adhesive hydrocarbons are removed. With such oils it may, therefore, be necessary to increase the rate of oil feed to insure maintenance of the lubricating film. On the other hand, filtered oils can be atomized more readily by the steam while the drops are being fed into the steam line. Furthermore, in the presence of high steam temperatures the adhesiveness of any cylinder oil will be reduced; another



Vertical separator removing oil and water by centrifugal action



Oil and water are removed by interception

instance entailing careful regulation of oil delivery based upon study of actual requirements of the particular engine.

Effect of Lubricant in Condensate

In consideration of the effect of lubricant in the condensate the essential thought is to study the duty which this latter is to perform after passage through the engine. Any such usage involves heat transfer. The manner in which this is brought about, however, will be of distinct importance. In open type heaters, where steam is passed directly to boiler-feed water, dye liquors or other fluids, the subsequent effect of the cylinder oil content of the condensate upon boiler tubes or textile fabrics should be carefully considered. In fact, this potential effect is the strongest reason for the use of oil separators or grease extractors. This is not the only field for such devices. Wherever indirect heating is practiced by use of condensed steam the possible insulating effect of any cylinder oil upon tube or shell surfaces must also be studied. Interesting data in this regard has been collected by the manufacturers of oil separators to substantiate the value of their equipment.

In brief, wherever exhaust steam or condensate is to be used in any manner for heating purposes, the oil content must be considered. For such exhaust, regardless of the original steam pressure, degree of superheat, valve design or type of engine, will carry a certain amount of oil unless no lubricant was used originally for cylinder lubrication. The latter may be regarded, however, as unusual practice unless vertical pumps or engines of the marine type are employed.

Removal of oil from condensate can be effectively accomplished by passage of the latter through a suitable oil separator or grease extractor. In the former, separation is brought about by directing the condensate against an arrangement of baffles to change the direction of flow momentarily or bring about a whirling motion involving centrifugal force. In one design of separator the baffles are V-shaped, direction of flow being abruptly changed. In another typical device, a ribbed baffle is used, the rib troughs serving to accumulate any entrained oil. In this way particles of oil, by coming in contact with the surfaces of the baffle plates or walls of the separator are effectively removed from the condensate.

Still another method of oil removal provides for use of water troughs surrounding the steam inlet and outlet ports. As the exhaust is passed through such a separator the entrained oil is intercepted and accumulated by these troughs.

In contrast with the principles involved in the operation of the average oil separator, the grease extractor accomplishes the same result by means of filtration. In this device the exhaust is passed through a number of thicknesses of special filter cloth or toweling. One effective filter element involves the winding of this cloth around a spool or core. The resultant element is then inserted in the extractor housing, passage of the exhaust being from inside out.

Emergency Repair on a Diesel Engine Cylinder

By W. W. DINGWALL

INVESTIGATION to determine the cause of water leakage into the cylinder of a diesel engine showed the trouble to be due to the ground joint between the pre-combustion chamber and the head being chipped for a space 1 in. long and $\frac{1}{16}$ in. deep, due to a fault in the casting. This engine was in daily service, and the several days required to fill up this fault by welding, and to regrind the surface, could not be spared.

Because of this an emergency repair with iron cement was tried, and worked out very well. All loose chips were removed, and the space cleaned with acid and with emery cloth until it was bright and smooth. Iron cement was forced into the fault and allowed to harden for several hours. After smoothing up somewhat, a valve grinding compound was placed on the pre-combustion chamber and the joint was ground until the chamber seated all the way around. In spite of the 500 lb. compression, and the temperature difference due to the intense heat in the cylinder and the cooling water around it, this repair has held for six months so far. Iron cement may also be advantageously used for stopping oil leaks in engine casings, and in pipe lines.

It is more or less standard practice at the present time to provide the air suction of a diesel engine with a filter to prevent dirt and grit being carried into the engine cylinders. However, little attention has been paid to the amount of dirt which is forced into diesel-engine cylinders along with the starting air, and it is important that the suction of the auxiliary air compressor be taken either from the main air-suction header or through independent air filter.

By A. M. HOUSER
and S. HIRSCHBERG
Crane Company, Chicago

Flexibility of Plain and Creased Pipe Bends

This engineering discussion of the comparative flexibility of creased and plain pipe bends is based upon tests made on bends of these types having the same major dimensions and is in answer to an article by W. Paul in the June 2 number of Power. The results have been applied to standard formula and used to compare the flexibility of a small radius creased expansion bend with a larger radius plain expansion bend. The effect of tangent length on flexibility was not considered in this later comparison

THE HIGH PRESSURES and temperatures used in modern plants require that greater care and thought be exercised in correctly proportioning and designing steam piping systems. When confronted with this designing problem, the following factors must be given consideration:

1. Flexibility to compensate for expansion due to temperature. 2. Stresses due to internal pressure and thrust. 3. Pressure drop and radiation losses. 4. Cost.

All four factors affect the economy of the plant; the pressure drop and radiation losses influence the plant efficiency; while the stresses and flexibility determine the reliability.

This article is confined to a discussion of the relative merits of the plain pipe bend as contrasted with the creased pipe bend, considering each factor in the order enumerated. Preliminary to this analysis, a description of tests and test data has been included which is based upon an investigation conducted at the Crane Company's experimental engineering laboratory.

A series of tests were made on 3-in. and 6-in. creased and plain bends of the double-offset expansion U-bend type having the same major dimensions to compare their relative flexibility. The 3-in. creased bend shown in Fig. 1 and a corresponding plain bend were tested. The dimensions of this set of bends are shown in Fig. 2; the end connections are also shown graphically. Another set of 3-in. bends, having long interposed tangents, shown in Fig. 3, was tested. The dimensions for the 6-in. bends are given in Fig. 4. Thus three pairs of creased and plain bends were tested for comparison.

All the bends were tested in practically the same manner. One end of the bend was fixed to an I-beam, while the other end was hinged, and guided in the axial direction by guiding rollers. The movement of the hinged or "free" end was measured in the direction of the axial force applied; deflection readings were observed on a steel scale, graduated to hundredths of an inch, which was fixed to the I-beam so that the movement of a needle point indicator attached to the flanged connection of the movable end of the bend could be easily read. The force or load was applied to the movable end of the bend by a hydraulic jack and pump combination which is clearly illustrated to the left in Fig. 1.

As a matter of interest, the Ames indicating dials placed around the periphery of the bends proved that the bends move symmetrical with the vertical axis. Furthermore, steam at 150 lb. pressure was permitted to flow through the bends during the tests to duplicate, as nearly as possible, the action of pipe bends when installed in steam lines. The dynamometer fastened across the flanged ends of the bend, Fig. 1, indicated that the bend itself tends to grow, creating a slight reactive force when the bend is in compression.

Figs. 2, 3 and 4 show the deflections for different values of force obtained from tests in graph and table form.

The creased bends shown in Figs. 3 and 4 were fabri-

cated in the Crane Company's Corwith Works in Chicago under the personal supervision of Alfred Schmidt, of Düsseldorf, Germany, the inventor of the creased, or corrugated, bend.

The prime purpose of an expansion bend is to compensate for the elongation or contraction of the pipe line due to temperature changes. The amount of expansion to be provided for can be determined when the temperature difference between extreme hot and cold conditions, the length of pipe, and the coefficient of expansion of the material are known. The next step is to select a pipe bend or bends affording sufficient deflection or spring to take care of the expansion of the pipe line. The most desirable pipe bend from the standpoint of flexibility is one that will deflect the maximum amount without inducing extreme fibre stresses in the material or excessive forces tending to tear the piping loose from its anchors. It may be well to mention that the radius of curvature of the bend, diameter of pipe, wall thickness, end connections, and the general layout all affect the flexibility of a given design of expansion bend.

Referring to the test results, the load-deflection relations may be summarized by assuming the average deflection for the creased bend as unity; the average deflection of the plain bend may be expressed in the form of a ratio as follows:

Size in.	Kind of Bend	Load-Deflection Ratio
3	Double offset expansion U-bend (Fig. 2)	1.20
3	Double offset expansion U-bend (Fig. 3)	1.35
6	Double offset expansion U-bend (Fig. 4)	1.09

This comparison of actual test results indicates a decided advantage of flexibility in favor of the plain pipe bend when both the creased and plain bends are made to the same dimensions.

It is claimed that the creased bend can be made with a bending radius as small as one and one-half times the pipe diameter; also that a creased bend made to this small radius can replace a plain bend made approximately to a radius of five pipe diameters. To bring out the fallacy of this statement and to ascertain the comparative flexibility of the creased bend of *this small radius* as contrasted *with a standard plain bend,* it will be necessary to resort to theoretical formulae.

At the present time there are no available formulae by which the deflection for the creased bend can be directly computed because of the many variables involved; namely, depth of crease, width of crease, pitch of crease, and wall thickness of crease. It will simplify the explanation to select the conventional type of double-offset expansion U-bend, Fig. 5, for comparison as the formulae are well established for the plain bend of this design. By applying the load-deflection factor obtained from tests for the creased bend to the plain bend formulae, fairly accurate results will be obtained. The formulae involved are first presented, followed by an example of the application of this theory to compare the flexibility of the creased and plain bends.

The general deflection formula is $\Delta_x = \frac{F}{EI}\int Ky^2 ds$,

where $K = \frac{12\,h^2 + 10}{12\,h^2 + 1}$, $h = \frac{tR}{r^2}$, I = moment of inertia of pipe cross section, E = modulus of elasticity, t = thickness of pipe wall, R = radius of bend, r = radius of pipe cross section.

The deflection for the double-offset expansion U-bend is obtained from the formula,

$$\Delta_x = \frac{39.88\,R^3KF}{EI}$$

or

$$F = \frac{EI\Delta_x}{39.88\,KR^3} \qquad (1)$$

The maximum longitudinal tensile stress due to bending is represented by the formula

$$S_{max.} = \frac{\beta Mr}{I}$$

where $\beta = \frac{2K}{3}\sqrt{\frac{6h^2 + 5}{18}}$ and M = bending moment.

The maximum stress in the double offset expansion U-bend occurs at the top of the bend, therefore, the maximum moment is

$$M_{max.} = F(2 + \sqrt{2})R$$

and

$$S_{max.} = \frac{3.414\,\beta\,FRr}{I}$$

or

$$F = \frac{IS_{max.}}{3.414\,\beta\,Rr} \qquad (2)$$

Combining equations (1) and (2), the relation of de-

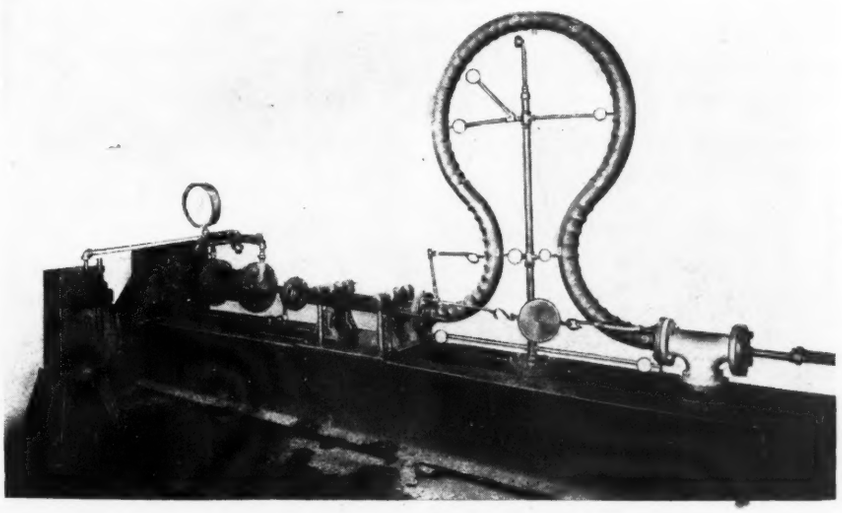
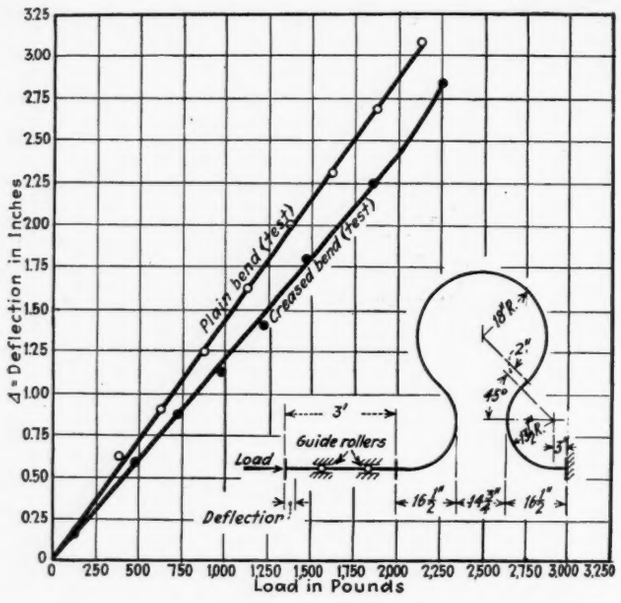


Fig. 1 — Test set up for 3 in. creased double-offset expansion U-bend

flection and stress can be obtained from the following:



RESULTS SHOWN IN CHART

Force, Pounds	Δ Plain Bend, Inches	Δ Creased Bend, Inches	R = Δ Plain Bend / Δ Creased Bend
500	0.72	0.60	1.20
1,000	1.44	1.20	1.20
1,500	2.15	1.80	1.193
2,000	2.86	2.40	1.19

Fig. 2—Load-deflection curves for plain and creased bends of 3.5 in. outside diameter seamless steel tubing of 0.218 in. wall thickness

$$\Delta_x = \frac{11.68\,KR^2S_{max.}}{\beta\,Er} \qquad (3)$$

As an example of the application of this theory to a practical case, compare the 6-in. creased and plain double-offset expansion U-bends shown in Fig. 5 assuming the permissible longitudinal stress ($S_{max.}$) as 12,500 lb. per square inch.

From the data in Fig. 5 on the creased bend $h = 0.278$, $K = 5.67$, $\beta = 2.08$.

Substituting in equation (2) gives,

$$F = \frac{28.14\ (12500)}{3.414\ (2.08)\ (10)\ (3.172)} = 1{,}560 \text{ lb. force.}$$

Substituting in equation (3),

$$\Delta_x = \frac{11.68(5.67)\,(100)\,(12500)}{2.08(30{,}000{,}000)\,(3.172)} = 0.418 \text{ in. deflection for 6-in. plain bend with 10-in. radius.}$$

Multiplying by the flexibility factor obtained from test to take in account the creases, it will be found that,

$$\Delta_x = 0.418\left(\frac{1}{1.09}\right) = 0.384 \text{ in. deflection for the creased bend.}$$

For the plain bend in Fig. 5 (b):

$h = 0.974$, $K = 1.75$, $\beta = 0.89$ and

Substituting in equation (2) gives,

$$F = \frac{28.14\ (12500)}{3.414\ (089)\ (35)\ (3.172)} = 1{,}040 \text{ lb. force.}$$

Substituting in equation (3),

$$\Delta_x = \frac{11.68(1.73)\,(1225)\,(12500)}{0.89(30{,}000{,}000)\,(3.172)} = 3.65 \text{ in. deflection.}$$

From these calculations and Fig. 5 it can be seen that it will require practically ten 6-in. creased bends with a 10-in. radius to obtain the equivalent deflection of one 6-in. plain bend with a 35-in. radius.

Using the same procedure, the number of 6-in. creased bends of larger radii required to obtain the equivalent deflection of one 6-in. plain bend with a radius of five pipe diameters can be summarized as follows:

Number of Creased Bends Equivalent to One Plain Bend

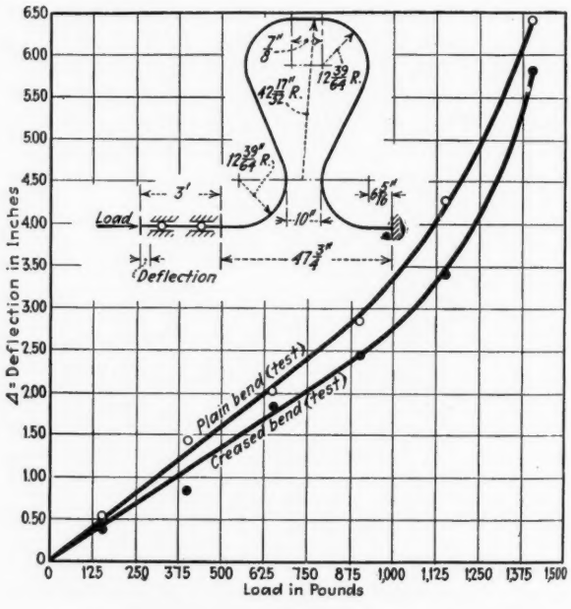
Radius of Creased Bend in Terms of Pipe Diameters	Number of Creased Bends Equivalent to One Plain Bend of Five Diameters Radius
5	1.09 (Test)
4	1.74
3	2.67
2	5.86
1½	9.5 (Fig. 5)

Stresses and Thrust

When designing a pipe bend, it is necessary to consider the stresses due to internal pressure and the stresses due to bending.

The allowable stresses due to internal pressure will determine the wall thickness of tubing, using accepted formulae. Any thinning of the pipe wall will increase the stresses nvolved.

An article "Creased Pipe Bends Offer Great Flexibility" by W. Paul of Düsseldorf, Germany, appeared in the June 2, 1931, issue of *Power*. Mr. Paul contends, "pipe bent to radii of three to four times its diameter shows a thinning of the outer wall, amounting to as much



TABULATED RESULTS FOR COMPARISON

Force, Pounds	Δ Plain Bend, Inches	Δ Creased Bend, Inches	R = Δ Plain Bend / Δ Creased Bend
151	0.531	0.375	1.41
403	1.437	0.843	1.72
655	2.031	1.853	1.095
907	2.875	2.468	1.16

Fig. 3—Load-deflection curves for plain and creased expansion bends of 6.625 in. outside diameter seamless steel tubing of 0.28 in. wall thickness

as 34 per cent, whereas it is claimed that creased-type bends have a uniform wall thickness throughout."

This statement is misleading. Using modern methods in bending pipe, such an excessive reduction in wall thickness is not accepted. In fact, such methods of fabrication would be prohibited. The following is more representative of actual conditions:

Radius of Curvature	Per Cent of Thinning of Outer Wall
3 Pipe Dia.	5 to 9
4 Pipe Dia.	3 to 6
5 Pipe Dia.	No appreciable thinning

As to uniform wall thickness of the creased bend, the reader should refer to Fig. 5 of the paper by E. T. Cope and E. A. Wert on "Load-Diflection Relations for Large Plain, Corrugated, and Creased Pipe Bends," presented at the A.S.M.E. meeting in Hartford, Conn., June 1, 1931, where it will be noticed that the wall thickness varies from 0.498 to 0.664 in., a variance of 33 per cent in the creased bend. The reduction of thickness below nominal is 6 per cent of the nominal wall thickness.

Mr. Paul favors the use of the double-offset expansion U-bends shown in Fig. 4 in preference to the conventional type shown in Fig. 2 and 5. Although the overall height of the bends is approximately the same, the 3-in. bend Fig. 3, with a long interposed tangent may be misinterpreted as being decidedly more flexible than the 3-in. bend, Fig. 2.

An inspection of the graphs shows that the proportional limit of the material (36,000 lb. per sq.in.) occurs sooner with the long tangent bend. In other words, a greater deflection cannot be obtained with the long tangent bend, Fig. 3 as compared with the conventional design of bend shown in Fig. 2, using the same permissible fibre stress or factor of safety. The conventional type double-offset expansion bend shown in Fig. 2 affords more uniform stress distribution.

By examination of the bends shown in Fig. 5, it can be seen that the force or anchorage load for the creased bend is 1,560 lb. as compared to 1,040 lb. for the large plain bend, although the stress in both bends is the same. Since it would be necessary to use ten creased bends with a 10-in. radius to obtain the equivalent deflection of the one plain bend, it will be necessary to provide ten anchors. Each of these anchors will be required to support at least 1,560 lb. force.

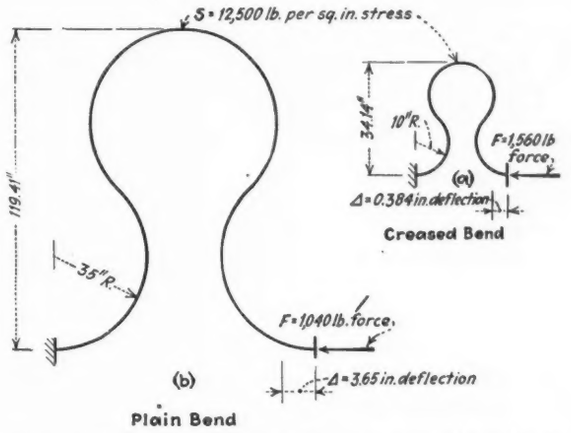
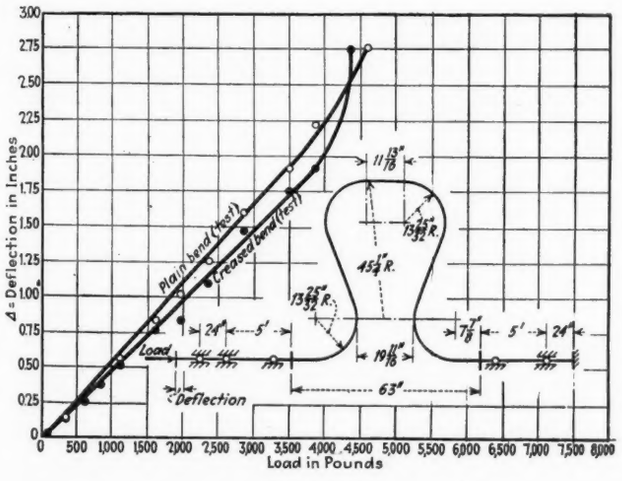


Fig. 5—Standard plain and creased U-expansion bends of 6.625 in. diameter seamless tubing 0.28 in. wall thickness showing force and deflection that produces a maximum stress of 12,500 lb. per sq. in.

The total combined stress including the bending stresses and the stress due to internal pressure should be carefully considered, as these stresses determine the reliability of the piping system. It has been recommended by authorities on this subject that a total combined stress of 16,000 lb. per square inch be used for design purposes. Limiting the bending stress to 12,500 lb. per square inch will provide ample margin to cover other stresses.



TABULATED RESULTS FOR COMPARISON

Force, Pounds	Δ Plain Bend, Inches	Δ Creased Bend, Inches	R = Δ Plain Bend / Δ Creased Bend
100	0.031	0.031	1.00
352	0.136	0.125	1.09
604	0.25	0.25	1.00
856	0.375	0.375	1.00
1,108	0.561	0.520	1.08
1,612	0.843	0.755	1.12
1,990	1.03	0.843	1.22
2,368	1.25	1.093	1.14
2,872	1.59	1.46	1.09
3,502	1.91	1.74	1.10
3,880	2.22	1.90	1.17

Fig. 4—Load-deflection curves for plain and creased expansion bends of 6.625 in. outside diameter seamless steel tubing of 0.28 in. wall thickness, both ends guided

Summary

Referring to the four factors enumerated at the outset of this article, the following summary is made:

1—*Flexibility*:

More creased bends are required to obtain the equivalent deflection of one plain bend, depending upon the dimension of the mean radius.

2—*Stresses and Thrust*

Heavier anchors, more structural supports and guides are required for bends having smaller radii. A bend with long interposed tangents tends to concentrate the stresses due to bending, while the conventional design affords more uniform stress distribution.

3—*Pressure Drop and Radiation Loss*:

One plain bend offers a considerable saving in pressure drop and radiation loss.

4—*Cost*:

In general one plain bend made to the standard radius can be purchased for less than a number of creased bends made to smaller radii. The cost of more anchors, the expense of providing for more guiding and supporting of a number of creased bends, together with the increased pressure drop and radiation loss involved, warrant careful investigation if the most economical installation is to be obtained.

A theory is presented explaining the reasons for the decreasing total heat of saturated steam above 425 lb. pressure

Why High-Pressure Steam Has Low Total Heat

By R. F. SORRELLS
Gulf States Utilities Co., Texas

HOW PARADOXICAL seems the statement that there is greater total heat in a pound of saturated steam under an absolute pressure of only 0.0886 lb. per sq. in. and 32 deg. F. than there is in a pound of saturated steam under an absolute pressure of 3,226 lb. per sq.in. and a temperature of 706.1 deg. F., and how many engineers recognize this as a fact?

A reliable steam table will give the total heat of a pound of saturated steam under a pressure of 0.0886 lb. per sq.in. absolute and 32 deg. F. as 1,073.4 B.t.u., and the total heat of a pound of saturated steam under 3,226 lb. per sq.in. absolute and 706.1 deg. F. as 925 B.t.u.

According to the steam tables, which are correct beyond doubt, the total heat of a pound of saturated steam at atmospheric pressure is greater than the total heat of a pound of saturated steam under 3,226 lb. per sq.in. pressure absolute. The difference is 225.2 B.t.u. in favor of the steam under atmospheric pressure. This means that it would require less heat to change a pound of water from 32 deg. F. to saturated steam under a pressure of 3,226 lb. per sq.in. and 706.1 deg. F. than it would to change a pound of water from 32 deg. F. to saturated steam exposed only to the pressure of the atmosphere.

The specific pressure of 3,226 lb. absolute has been used because it is the critical pressure of the steam and represents the highest pressure at which saturated steam may exist.

The pressure of 0.0886 lb. absolute represents the pressure at which the boiling point of the water is 32 deg. F. The steam tables express the heat of the liquid as that heat above 32 deg. F., thus this pressure represents the condition at which the heat of the liquid is zero and the total heat of the steam is equal to the latent heat of evaporation

At the critical pressure the latent heat of evaporation has become zero and the total heat of the steam is equal to the heat of the liquid. Figure 1, shows the heat of the liquid, latent heat of evaporation, and the total heat of saturated steam for various pressures.

The following quotation is taken from an explanation of the operation of the throttling calorimeter, "The principle of its operation is as follows: a pound of saturated steam at a high pressure contains more heat than a pound of saturated steam at a lower pressure—etc."

In the past, when 400 pounds per sq.in. was considered a very high pressure, this statement would pass undisputed. However, with pressures in common practice well above this pressure today, and with new steam tables reaching the critical pressure for steam, the inaccuracy of this statement becomes evident. It seems that at the absolute pressure of about 425 pounds per sq.in. the total heat curve for saturated steam begins to drop with further increase of pressure and temperature. Fig. 2, shows this clearly.

In seeking an explanation of this eccentricity, the following conclusions present themselves:

It is generally conceded that water in a liquid state is composed, not of the simple molecule H_2O, but of such complex molecules as $(H_2O)_2$, $(H_2O)_3$, or $(H_2O)_4$, while in the vaporous state, the molecules are entirely of the form H_2O. Assuming this to be true, the high latent heat of evaporation of water under normally high pressures as well as several peculiar properties of water are easily explained.

For instance, if water is made up of the molecule in the form $(H_2O)_2$ and the steam is made up of H_2O entirely, there will be twice as many molecules in the form of steam as there would be in the water. However, the combined weights of all of the molecules would not be altered. Therefore, the weight of the steam molecule will be only half that of the water molecule and its mean velocity will be greater.

As the temperature of a pound of water is raised under a given pressure to its boiling point the condition is reached where the molecules begin to break up. It is

quite logical to assume that some energy is used in breaking up each of these molecules into the form H_2O and in separating the newly formed molecules. Too, since the weight of the steam molecules, H_2O is less than the weight of the water molecule $(H_2O)_2$ its velocity will be greater.

The total kinetic energy of the molecules of a fluid may be expressed as follows:

$$E = \frac{WV^2}{2g}$$

Where, W = combined weight of all molecules
g = acceleration of gravity
V = mean velocity of the molecules

Now, since W has remained constant and V has increased in changing from the heavier to the lighter molecule, the vapor will contain more kinetic energy than the liquid at a given temperature. This additional energy is termed internal energy of evaporation.

As this newly formed vapor expands to its new volume, it does work in pushing back the surrounding vapor or container. The energy be added to the vapor to do this work is termed external latent heat of evaporation.

Instead of the theory that steam is composed entirely of molecules in the form of H_2O while the liquid from which the vapor was generated is composed of the complex molecules $(H_2O)_2$ or $(H_2O)_3$, let it be agreed that the saturated steam at normally low pressures may be made up almost entirely of molecules in the form of H_2O, but that, as the pressure and boiling point of the liquid is increased, some of the molecules may go into the vapor without first breaking up into the form H_2O. Thus, some of the molecules $(H_2O)_2$ or $(H_2O)_3$, etc. may pass directly into steam.

It should take less heat to generate this portion of the steam composed of $(H_2O)_2$ or $(H_2O)_3$, etc., than it would to generate that portion of the steam composed of (H_2O), since no energy was needed to break up these molecules and impart more energy to them as a whole.

Now, as the pressure and temperature is still further increased the proportion of these complex molecules to the simple molecule in the steam is increased until at 3,226 lb. per sq.in. absolute and 706.1 deg. F., the vapor is composed entirely of the complex molecules.

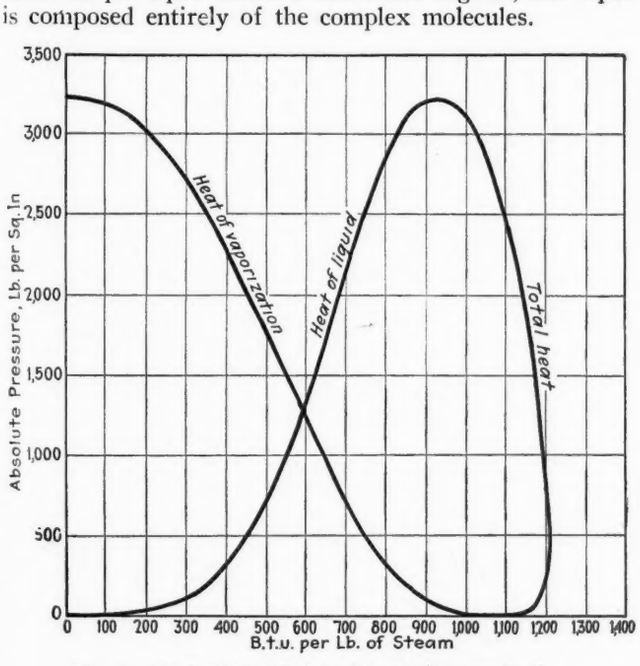


Fig. 1—Heat of liquid, latent heat of vaporization and total heat of dry saturated steam up to critical pressure

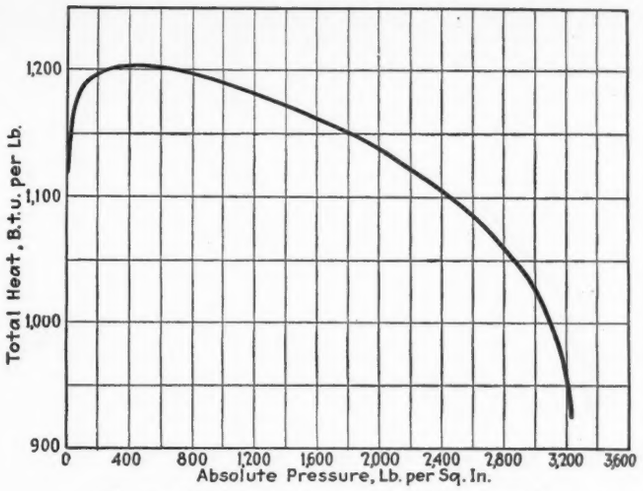


Fig. 2—Total heat of dry saturated steam is maximum at about 425 lb. abs. pressure

Does this not clearly account for the continuously decreasing latent heat of vaporization of the fluid and the gradually decreasing rate of total heat increase until at 425 lb. per sq.in. absolute the total heat curve reverses and begins to decrease at a rapidly growing rate until at the critical point it has reached a minimum?

When water at atmospheric pressure and 32 deg. F. is heated to the boiling point or 212 deg. 180 B.t.u. are added to it. At this point all or practically all of the complex molecules of the water begin to break up into the simple molecule. In completing this change 970.2 B.t.u. are added to the fluid, giving a total heat of 1,150.2 B.t.u. to the pound of saturated vapor.

Beginning with a pound of water under 3,226 lb. pressure absolute and 32 deg. 925 B.t.u. must be added to bring it to the boiling point or 706.1 deg. Unlike the water under lower pressure, there will be no breaking up of the complex molecules into the simple H_2O molecule and, therefore, no extra energy must be added to the water at this point to change it into the vaporous state. Instead, it passes directly into this state without change in energy. Thus, the lower total heat.

At some intermediate condition, say 3,200 lb. and 704.9 deg. F., at which boiling will begin, only a small percentage of the complex molecules break up and much less heat must be added to the liquid to break up these few molecules into the simple molecule than would be necessary at a lower pressure. The remaining complex molecules pass directly into the vapor with no additional energy. The energy needed to produce this effect and push back the surrounding vapor amounts to 75.9 B.t.u. under this high pressure, bringing the total heat of the vapor to 962.9 B.t.u.

After reading this discussion, some may raise the question, "Where is the benefit of steam used in practice above 425 lb. absolute? Why isn't 425 lb. the most economical pressure if saturated steam above this pressure has less total heat than the saturated steam at this pressure?"

As an answering example take saturated steam under the two pressures of 100 lb. absolute and 1,075 lb. absolute. The total heat of a pound of saturated steam under these two very different pressures is the same being 1186.6 B.t.u. in both cases. This means that beginning with a pound of water under 100 lb. pressure absolute and a temperature of 32 deg. F. and a pound of water under 1,075 lb. pressure absolute and 32 deg. F. a pound of saturated steam could be generated in each case by

the addition of 1,186.6 B.t.u., pressures remaining constant. This does not mean, however, that each pound of the saturated steam now possesses the same ability to do work.

The steam in each case may give up its energy in either of two ways or in an infinite number of combinations of these two ways. It may give up its energy entirely in the form of heat or it may give it up entirely in the form of work.

Assume that each of these two pounds of steam is allowed to pass through an ideal turbine in which it is expanded adiabatically to atmospheric pressure in each case. In this process the energy, in each case, is given up entirely in the form of work, there being no heat transfer. A Mollier diagram for steam indicates that expansion of the higher-pressure steam will make available 289 B.t.u., or 224,800 ft.-lb. of work, and the lower-pressure steam 138.4 B.t.u., or 107,771 ft.-lb. of work.

Each of these two pounds of steam were generated from water at 32 deg. F. by the addition of equal amounts heat. But when expanded adiabatically to the same pressure there is available from the lower pressure steam only 46.4 per cent as much work as from the higher pressure steam.

Water seems to be made up, not of the simple molecule H_2O, but of the complex molecule in the form $(H_2O)_2$, $(H_2O)_3$, $(H_2O)_4$, etc. It is the breaking up of these molecules, increasing their velocities and pushing back the surrounding fluid or container that accounts for the latent heat of the liquid.

Practically all of these molecules are broken up into the simple molecule H_2O in passing into a vapor at normally low pressures. However, with increase in pressure fewer and fewer of the molecules break up, until at 3,226 lb. per sq.in. absolute, the critical point for steam, none of these molecules break up but pass directly into the vapor form.

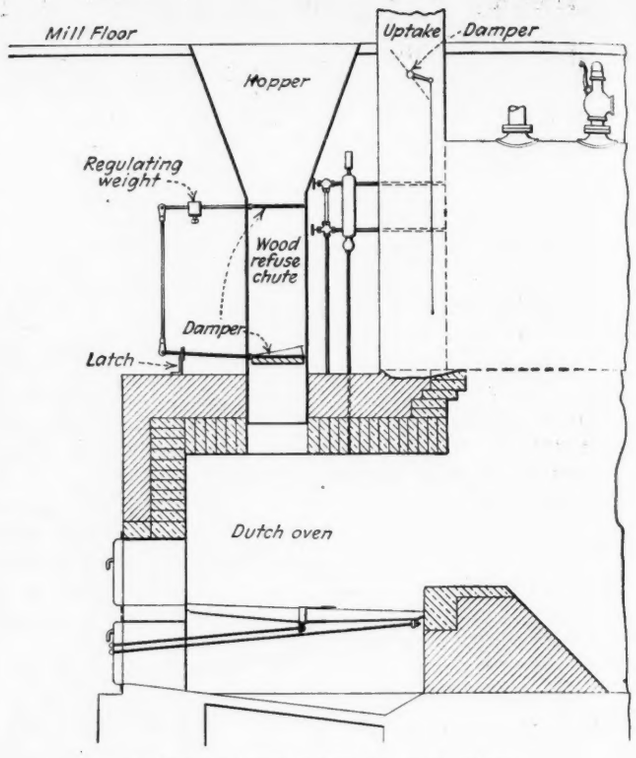
This accounts for the gradually decreasing latent heat of vaporization of steam with increased pressure. It also accounts for the fact that saturated steam under a very high pressure may contain less total heat than saturated steam under a lower pressure and yet be able to do more work.

▼

Method of Feeding Wood Refuse

A SAWMILL in northern New England installed a horizontal return tubular boiler some time ago to supply steam to several engines. Because overheating of furnace walls and stacks, as well as the dropping of hot embers from the stack in the near-by woods, the furnace was changed to the Dutch-oven type as shown. At first a duct fed the wood refuse from the mill floor above onto the top of the Dutch oven. There were two holes cut through the arch with removable covers, one on each side of the grate.

The refuse piled up in a heap and the fireman had to climb up on the arch and shovel it in first one hole and the nthe other, and then to climb down and level off the fire. The sawdust and light shavings burned in suspension, while the heavier scraps and chips fell to the grates, where they piled up and burned in bed form.



Automatic dump feeder for wood refuse

In an effort to improve the system the following changes were made: A sheet-steel hopper of convenient size for this particular mill was built directly under the millfloor. This provided extra fuel-storage space. It also reduced considerably the moisture content of the refuse stored in the hopper because of heat radiated from the boiler front and uptake. Two butterfly dampers were made with shafts welded at one edge instead of the middle. One butterfly was installed in the chute from the hopper to the arch of the Dutch oven just below the hopper, and the other was installed at the bottom of the chute. This one was chipped rough on the under side and a layer of fireclay was applied. The top of this damper had a piece of sheet steel spotted on which was bent two ways so as to divert the fuel in two directions as it entered the oven. The lever arms of the two dampers were connected by a rod with clevises on each end, as shown.

A weight on the top lever is adjusted to regulate the weight of wood refuse that piles up on this damper. When the weight of refuse becomes sufficient to overbalance the regulating weight the damper dumps it onto the lower damper, which swing open under the weight of refuse also and spread the fresh fuel on the grate. A spring steel latch on the bottom arm holds the weight a little longer than its normal opening time, so that it swings open quickly and also latches itself when closed again.

This fuel-firing device results in a more even firebed and a reduction in the work of firing, since it is only necessary to level off after every two or three fuel dumps. Once in a while a larger chip than usual prevents the butterflys from closing tight and latching. Such a chip can be dislodged by opening the damper slightly by hand. The hopper should be left empty when the boiler is shut down, so as to prevent any chance of fire.

Speed Control for Large Wound-Rotor Motors

By L. E. MARKLE
Control Engineer
Westinghouse Elec. & Mfg. Co.

FOR alternating-current power installations requiring speed adjustment a wound-rotor motor with a variable secondary resistor are commonly used. Adjustment of the secondary resistor to obtain the desired speed is often accomplished by a three-phase faceplate type of control, the main connections of which are given in Fig. 1.

Wound-rotor motors for speed control are used in such large capacities and require so many speed-control points that faceplate or similar devices are not always satisfactory. To meet these demands magnetic contactors can be operated singly and in combination with each other to produce the desired results. Three-pole magnetic contactors are used with one pole connected in each phase, as in Fig. 2. The coils of the magnetic contactors are not shown, but they are controlled by a master speed switch. By this plan of speed control many combinations of contactors are possible and the desired results are quite readily obtained.

In Fig. 2 the five three-pole contactors are numbered 1, 2, 4, 8 and 16, and for simplicity these same numbers may represent the amount of resistance per phase controlled by each contactor. Such an arrangement therefore might represent a total of $1 + 2 + 4 + 8 + 16 = 31$ ohms resistance per phase. An actual design probably would not use such high resistance per phase, but should be divided into steps of like proportions.

Fig. 3 indicates the sequence in which the five contactors, Fig. 2, will be closed in order to reduce the 31 ohms resistance to zero in increments of one ohm at a time, thereby providing 32 different speeds. For example, on speed point No. 1 all contactors are open and there are 31 ohms resistance in each phase. On speed point No. 2, contactor No. 1 closes and cuts one ohm resistance out of each phase. When the control is moved to speed point No. 3, contactor No. 2 closes and No. 1 opens. Closing No. 2 contactor short circuits two ohms resistance in each phase, reducing the resistance in series to 29 ohms. Moving the control to point 4 causes No. 1 contactor to close and No. 2 to remain closed. This cuts three ohms resistance out of each phase and reduces the series resistance to 28 ohms per phase. The closed contactors are indicated by *X*; a study of these will show how they close and open to reduce the resistance per phase in steps of one ohm.

Fig. 4 shows the sequence of magnetic contactors for the same total resistance and number of contactors as Fig. 3 except that the resistance is not changed by increments of one ohm throughout the entire range. In Fig. 4 the first four points will each reduce the effective resistance in increments of four ohms; the next four points will each decrease the effective resistance in increments of two ohms; and the remaining seven points will each decrease the effective resistance by one ohm. Comparison of Figs. 3 and 4 indicates that with the same equipment there are 32 or 16 speeds, depending entirely upon the fineness of speed control desired. The combination illustrated in Fig. 3 will require a 31-point master speed switch, whereas the combination in Fig. 4 will require only a 15-point switch.

By a suitable design of resistor, number of contactors and sequence of operating the contactors, practically any number of speed points and accurate speed regulation can be obtained. The application to large-size motors will be limited only by the current-carrying capacity of the magnetic contactors and the ability of the master speed switch to handle the coil currents of the magnetic contactors.

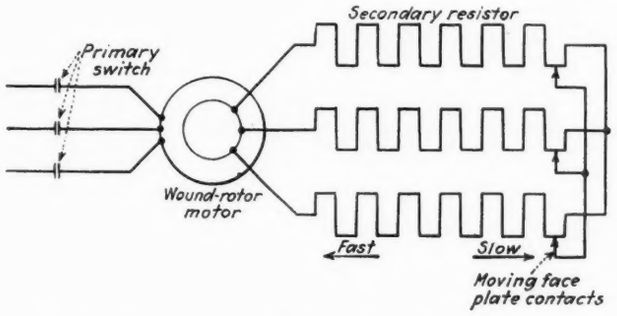


Fig. 1—Diagram of faceplate control for the secondary resistance of a wound-rotor induction motor

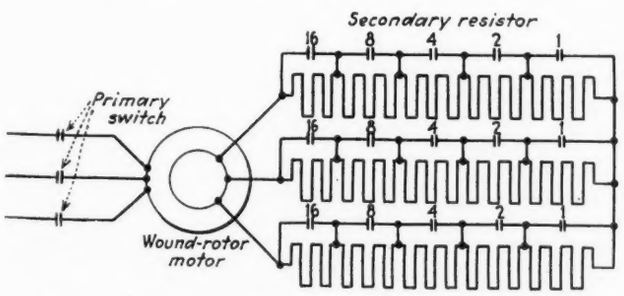


Fig. 2—Diagram of secondary-resistance control for a wound-rotor induction motor to give a total of 32 speed points

Effec. Res., Ohms	Speed Points	Sec. Contactor 16	Sec. Contactor 8	Sec. Contactor 4	Sec. Contactor 2	Sec. Contactor 1
31	1					
30	2					X
29	3				X	
28	4				X	X
27	5			X		
26	6			X		X
25	7			X	X	
24	8			X	X	X
23	9		X			
22	10		X			X
21	11		X		X	
20	12		X		X	X
19	13		X	X		
18	14		X	X		X
17	15		X	X	X	
16	16		X	X	X	X
15	17	X				
14	18	X				X
13	19	X			X	
12	20	X			X	X
11	21	X		X		
10	22	X		X		X
9	23	X		X	X	
8	24	X		X	X	X
7	25	X	X			
6	26	X	X			X
5	27	X	X		X	
4	28	X	X		X	X
3	29	X	X	X		
2	30	X	X	X		X
1	31	X	X	X	X	
0	30	X	X	X	X	X

Fig. 3 (Left) — X indicates the sequence in which the contactors, Fig. 2, close and open to give 32 points of speed control

Effec. Res., Ohms	Speed Points	Sec. Contactor 16	Sec. Contactor 8	Sec. Contactor 4	Sec. Contactor 2	Sec. Contactor 1
31	1					
27	2			X		
23	3		X			
19	4		X	X		
15	5	X				
13	6	X			X	
11	7	X		X		
9	8	X		X	X	
7	9	X	X			
6	10	X	X			X
5	11	X	X		X	
4	12	X	X		X	X
3	13	X	X	X		
2	14	X	X	X		X
1	15	X	X	X	X	
0	16	X	X	X	X	X

Fig. 4 (Above)—X indicates the sequence in which the contactors, Fig 2, close and open to give 16 points of speed control

READERS' COMMENTS

Supercharging Is One Answer

IN THE March 3 number under the heading "Supercharging Is One Answer" there appeared a brief and valuable editorial on the merits of exhaust-turbine-charged four-stroke-cycle diesel engines.

As sole designers and manufacturers of the exhaust turbine-blowers used in conjunction with the "Buchi" system of turbine-charging, we call attention to the curve-sheets covering the results of a pressure-charged M.A.N. type high-speed diesel engine, and of a S.L.M. turbine-charged diesel, shown in the illustrations.

The engine in Bougie has six cylinders, 370-mm. (14.57-in.) bore, at 520-mm. (20.47-in.) stroke, and is rated for 730 b.hp. at 273 r.p.m. The Murcia plant has a diesel with 8 cylinders of the same dimensions and is rated for 825 b.hp. at 250 r.p.m. Both machines are of the solid-injection type. The results of the acceptance test fully comply with the statements given in the editorial.

We are taking the liberty to point out some further valuable features on turbine-charged diesel engines compared with the standard type of four-stroke-cycle engine.

For the users of diesel engines there are the lower weight and the smaller over-all dimensions of the engine set, as well as the lower initial costs of the plant and lower fuel and lubricating oil consumption.

The supercharged engine has a higher overload capacity, normally up to about 30 per cent over the normal turbine-charged rating. There should be lower prices of the spare parts, and the circulating water cooling plant need not be so large as that needed by an uncharged engine of the same maximum capacity.

For the manufacturers of diesel engines there is the smaller number of different engine types, which means less investment in patterns; a certain engine may cover a range from 125 to 150 per cent of its normal rating at the same speed.

With the same workshop installations higher-rated machinery can be turned out; works now building engines to a maximum of 1,250 b.hp. can supply turbine-charged engines up to 2,000 horsepower.

In answer to the statement in the editorial that, contrary to marine installations, only few stationary plants with exhaust turbine-charged machinery are in operation, I beg to point out that there are 36 stationary plants with 46 diesel engines using exhaust turbine-blowers totaling 49,080 b.hp. and 37 ships with 65 main engines totaling 159,895 b.hp., or 73 installations with 111 turbine-charged diesel engines and an output of 208,975 b.hp. Of these plants 67 are in operation, and the others are in course of manufacture.

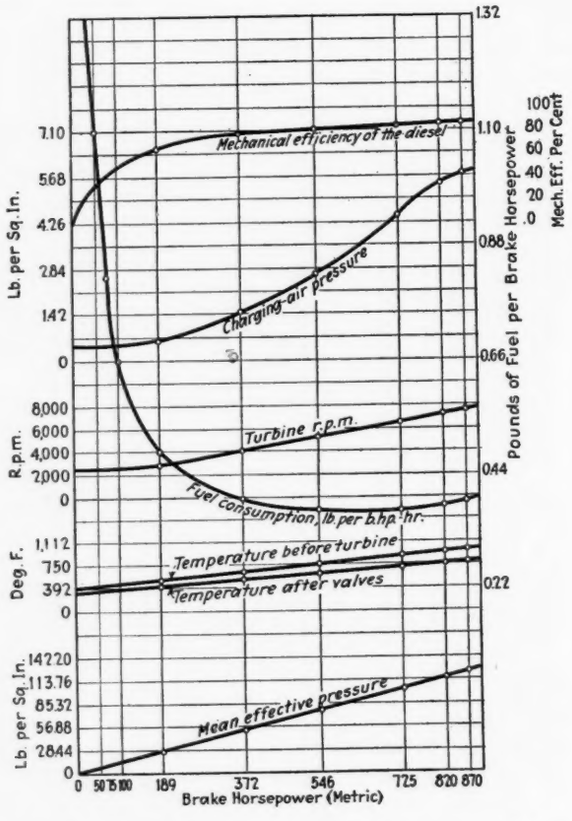


Fig. 1—Results obtained from a M.A.N. turbine-charged diesel

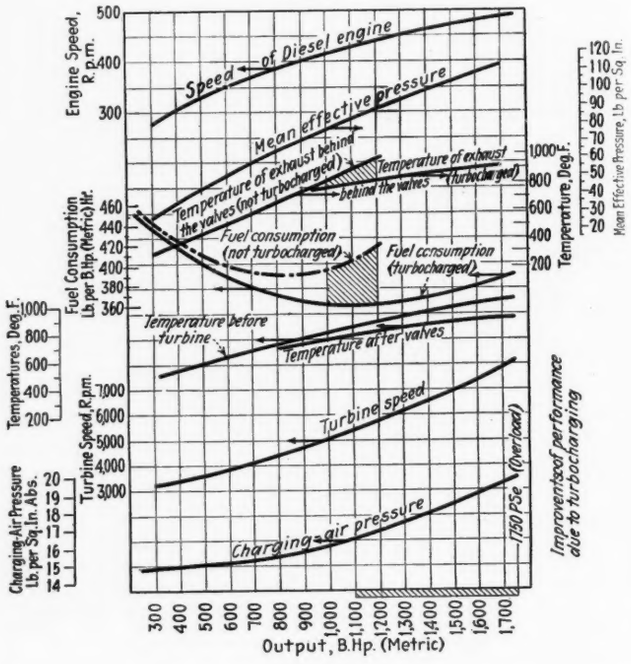

Speed of Diesel engine
Mean effective pressure
Temperature of exhaust behind the valves (not turbocharged)
Temperature of exhaust behind the valves (turbocharged)
Fuel consumption (not turbocharged)
Fuel consumption (turbocharged)
Temperature before turbine
Temperature after valves
Turbine speed
Charging-air pressure
1750 PSe (overload)
Improvement of performance due to turbocharging
Engine Speed, R.p.m.
Fuel Consumption Lb. per B.hp. (Metric) Hr.
Temperatures, Deg. F.
Turbine Speed, R.p.m.
Charging-Air Pressure Lb. per Sq. In. Abs.
Temperature, Deg. F.
Mean Effective Pressure, Lb. per Sq. In.
Output, B.Hp. (Metric)

Fig. 2—Test on a turbine-charged Swiss Locomotive Works diesel

J. W. MEYER.
Brown, Boveri & Company.
Winterthur, Switzerland.

Handling Low-Volatile Fines

I WISH to extend my compliments to C. Pritchard for the so brief yet clear and concise an article as was his on page 208 in the Aug. 11 number.

From past experiences in burning low-volatile coal on Type E stokers, weighing the coke "carryover" taken from the combustion chambers and checking the coke fines as taken from the stack base, I have arrived at 4 per cent as a conservative figure for the B.t.u. loss from the use of a 14,600-B.t.u. coal.

H. BIDWELL, *Chief Engineer,*
Amherst, Mass. Mass. Agricultural College.

Review Power History at Centenary Meeting of British Association

By JOHN B. C. KERSHAW

THE CENTENARY MEETING of the British Association for the Advancement of Science, which was held in London from Sept. 23 to 30, came up to the most optimistic estimates made as to the attendance of members and associates, the value and importance of the papers and addresses presented for discussion at the meeting. An attendance of over 5,000 proved the hold that this annual gathering of scientists has now attained upon the educated portion of the British public. The very large number of foreign scientists who were attracted to this year's meeting was due in some measure to the fact that it coincided in date with the celebration of the centenary of Michael Faraday's discovery of magnetic induction.

The work of the association was carried out under thirteen separate sections and it is of course quite impossible to give any summary of the papers read and discussed at this year's meeting, for a mere list of titles and authors would cover more than the whole space allotted to this report. The writer therefore will confine himself to the four papers which are likely to be of exceptional interest and value to the readers of *Power*.

Steam and Oil Engineering

Sir Alfred Ewing, in his presidential address on Friday, Sept. 25, to the Engineering Section (which was also the Bramwell Trust Lecture), dealt with the development of steam and oil engineering, during the last fifty years, taking as his text the prophecy of Sir Frederick Bramwell, made in July, 1903, that "although there would still be steam engines remaining in work in 1931, the output of steam engines in that year would be small, as compared with the output of internal combustion engines."

The following extracts from Sir Alfred Ewing's address, contain the gist of his reply to Sir Frederick Bramwell's prophecy:

"You do not need to be told that the prediction has in great measure failed to come true, for steam is neither dead nor dying, and on the contrary its use has immensely developed both on land and sea. Today, it is a much more efficient medium than it was before, for the conversion of heat into work; and you find it actuating engines of vastly greater individual and aggregate power, than any that were ever imagined when Bramwell spoke. But alongside of that we have wonderful achievements also on the part of the internal combustion engine, which go far to justify the enthusiasm that stirred Bramwell thirty years ago. Looking back now, one is amazed at the boldness of his prophetic outlook. It was more than bold, for it was almost foolhardy."

After describing the developments of the internal combustion engine using oil in place of gas and its application for air and road transport purposes, Sir Alfred Ewing passed on to consider the striking and revolutionary changes, brought about by the invention and application of the steam turbine to power production. According to a return published by the Electricity Commissioners in 1930, oil and gas engines together only formed 1½ per cent of the power generating plant in British electricity stations, and over 95 per cent was generated by steam. Nor is steam being driven out by oil in marine engineering, although a superficial observer might think otherwise. As an example of the complications of diesel engines when applied to the propulsion of large liners, Sir Alfred Ewing quoted the case of a ship of some 17,000 to 18,000 tons in which twelve diesel cylinders, operating on each of four shafts, produced a speed of 18 to 20 knots. In addition to these 48 main cylinders, there were 24 which were serving auxiliary services, essential to the working of the main engines.

Considering the number of working joints, valves, valve rods and tappets, besides pistons and connecting rods, can such an accumulation of reciprocating pieces be considered a real engineering advance as compared with the cozy hum of a turbine-engine room? None of the greatest and fastest ships are motor-driven, neither the Leviathan, which at present heads the list, nor any of the other big ships with tonnages of 40,000 or 50,000 and speeds ranging from 20 to 28 knots. Lloyd's list of marine engines under construction at the end of March 1931 shows that the average shaft horsepower of the 51 turbines is nearly 20,000, whereas that of the 328 motors is not much over 2,000, and the present fashion, if one may call it so, is to put motors into ships of moderate size and power.

In the concluding paragraph of his address Sir Alfred Ewing emphasized the dangers of an over-mechanized world, and stated that the gifts of the engineer to progress are only good if wisely used, and that the new powers placed in man's hands may be used to his own hurt.

Analysis of Explosion Flames

An evening lecture on this subject was delivered by Professor William Bone, Sept. 24, and was illustrated by experiments and by a series of most remarkable photographs of explosion flames. The earliest forms of apparatus used by Mallard and Le Chatelier, for photographing flames were first described and details were given of the results obtained by the research workers at the Imperial College of Science and Technology in London, with improved forms of this earlier apparatus and method. Professor Bone then described in some detail the later apparatus designed by R. P. Fraser, which has so increased the analyzing power of the photographic method that it is now possible to photograph and measure movements in explosion flames occurring periodically with frequencies up to 250,000 per second. With a new type of Mr. Fraser's camera embodying the principle of a mirror which revolves in vacuo at a velocity of 16,000 r.p.m. and by projecting the image of the explosion flame onto a stationary film, the research workers of South Kensington hope to increase the analyzing power four or five-fold, and in the near future, to photograph and measure periodic flame movements, occurring with frequencies of 1,000,000 per second.

As regards the information obtained from this investigation, the lecturer stated that it was now proved that the speed of explosions can be abruptly raised from a lower to a higher uniform value when a flame is overtaken by what is known as a "shock" wave, travelling in the same direction, and much new light has been thrown on what may be termed the "pre-detonation" phase of explosion. This occurs when the flame is advancing at a speed greater than that of any "shock" wave, through the unburnt medium, and is therefore overtaking any such waves which are ahead of it. The investigation has also shown how detonation is ultimately set up when a rapidly moving flame is just about to overtake a "shock" wave immediately in front of it. For then an ignition ahead of the flame front occurs and immediately afterwards detonation is set up.

A series of remarkable photograps were also shown, relating to the phenomenon of "spin," which was first observed five years ago by Campbell and Woodhead, working in the laboratory of the late Professor Dixon, and later confirmed by research workers, in the laboratories at South Kensington. Limits of space will not permit any details of this investigation to be given here.

Faraday's Steels and Alloys

Sir Robert Hadfield, the famous metallurgist, contributed a paper in connection with the centenary of Faraday's electro-magnetic discovery to the engineering section of the association, on Sept. 24. It is not generally known that Faraday before he commenced the series of electro-magnetic and electro-chemical investigations which have made his name world-famous, carried out at the Royal Institution laboratory, in the years 1819 to 1824, some experimental work upon the production of metals and alloys. During this period he made and examined alloys of steel with at least sixteen different elements and four special compounds. Sir Robert Hadfield

was allowed by the managers of the Royal Institution to examine and analyze the 79 specimens which are all that remain of Faraday's work and which had been for 100 years stowed away in the cellars of the Royal Institution in a deal box. The total weight of these 79 specimens was 7 lb. 14 oz., and only 13 weighed 3½ oz. or over, and the remaining 66 averaged only 1.10 oz. each. A careful search failed to reveal any trace of the high platinum and rhodium alloys which Faraday described in his notes, nor has it been possible to discover the heavy ingots of Faraday's alloys which were made from his instructions by the Sheffield firm of Sandersons.

With such a small total weight of material, and with so many alloys of different and quite unknown composition, and with the further handicap of having to work with only a small portion of each specimen, Sir Robert Hadfield has succeeded in determining the composition, nature and properties of the greater number of them and has discovered much information of value at the present time. From the information thus obtained, it is proved that Faraday's early work upon steels and alloys constituted an important and valuable research and entitled him to be regarded as a metallurgical investigator of the highest ability, and the pioneer of alloy steels.

Electrical Engineering

Dr. Elihu Thomson, in his paper, "Pioneering Work in Electrical Engineering Half a Century Ago," stated that following the centenary exposition held at Philadelphia in 1876, and the exposition at Paris in 1878, his attention was drawn to the possibilities for new work in the field of electrical engineering. The paper related therefore to some of the developments undertaken by him in association with Professor E. J. Houston, and leading to the system of lighting known as the Thomson-Houston system of arc-lighting. This early work, formed the basis of the British Thomson-Houston Company, the Compagnie Francaise Thomson-Houston and similar business developments in other countries. The combination in 1893 of the Edison General Electric Company and the Thomson-Houston Company, in the United States gave rise to the present world-renowned General Electric Company.

The paper first described the dynamo, which was built by the author in 1878, and may be considered a pioneer machine. It was a self-exciting dynamo with a commutator for continuous or direct current, and it was also a two-phase alternator with collecting rings. Early in 1879 this machine was used at the Franklin Institute in Philadelphia to operate a pair of transformers connected to it in parallel by the fine wire primaries of these induction coils. These were later designated as of the "shell" type, because the iron of the magnetic core was extended as a shell over and enclosing the copper wire coil, which constituted the primary and secondary parts of the circuit. The coarse wire secondaries of these transformers operated the load at a reduced potential, and as this work ante-dated any production of incandescent lamps, a special form of small vibrating arc lamp was used, as were also separate coils of resistance wire rendered incandescent. It is evident, therefore, that this installation was a pioneer realization of the essential features of the transformer systems in use today, and it was followed in a few years by a widely expanding application of the principles involved.

The author also described the invention of the three-phase winding for the first dynamo, the armature of which carried such a winding. It was designed and built in 1878-9, and formed the subject of a patent No. 223,557, dated Jan. 13, 1880. The original machine is preserved at the United States National Museum, in Washington, D. C. The description, in the specification of a patent relating to this, included the provision of three collector rings, which allowed the output to be alternating current when desired, thus agreeing in that particular, with the preceding two-phase machine. The bearing of this type of construction on modern power practice is evidently fundamental. Interesting details concerning the construction of the first "three-coil" machine were also given in Professor Elihu Thomson's paper; and the peculiar arrangement for regulation, in conjunction with the three-coil early dynamos for maintaining a constant current for a circuit of arc lamps was described.

The author closed his paper by correcting a widely-spread misconception concerning the function of the unique air-blast commutator mechanism used in the machines of the old Thomson-Houston type. Its function was always to secure steadiness in the lamps, and not as often stated, merely a bold expedient to blow out the sparks at the commutator.

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Diesel Engines as Peak Load Units*

By S. A. HADLEY
McIntosh & Seymour Corp.
Kansas City, Mo.

CERTAIN CHARACTERISTICS of the diesel engine, such as absence of stand-by losses, the ability to start quickly with no preliminary expense, and its operation after being started with minimum attention, have always been recognized as favoring its use to carry intermittent loads, including peak loads in central stations. Other characteristics, such as the limited capacity of single units and the cost of installation, have been unfavorable factors for such use. The characteristics first mentioned remain unchanged, along with its inherent high efficiency which is practically the same for all sizes.

Economic pressure has forced the development of larger-size units and of more compact designs, operating at higher speed which have decreased not only the first cost of the unit but the cost of generators attached to them and of buildings to house them. Thus the field open to their use in intermittent service, particularly peak-load service, has been greatly widened.

The general rise of prices of all commodities due to the World War occurred just at the time when the diesel engine was being introduced into general commercial and industrial use in this country and is responsible to a large extent for the idea that the cost of diesel-engine installations are relatively high.

As an example of present prices there might be mentioned a 1,200-hp. two-unit municipal plant for which bids were received in November, 1930. The plant was to be complete, including building, foundations, fuel storage and handling, cooling-water equipment with softener, all piping, switchboard and wiring, and accessories. The accepted bid made the cost, including an engineering fee of 5 per cent, substantially $110 per kw., which was not very far from the average of all bids submitted.

More study should be made of the possibilities for reducing the cost of current when distributed to the point of use by the employment of diesel engines of moderate capacity, that is, from 300 to 2,000 hp., installed in suitably located outlying sub-stations and operated regularly over peak-load periods. In this way they would serve the double purpose of peak-load equipment and standby or emergency equipment. Installation costs would be reasonably low, even though the station capacity be relatively small, because such installations would almost invariably consist of single units which permit the lowest installed cost per kilowatt capacity. Their operating costs would be low, because they would be run only with a good load and would have low attendance charges.

In a community of moderate size, say from 1,500 to 2,500 population, in the Middle West, served by a transmission line from a large central station, one man usually is employed to look after the distribution system and sub-station

*Abstract of paper presented at the Kansas City, Mo., meeting of the American Society of Mechanical Engineers, Sept. 7 to 9, 1931.

equipment, and this employee could, with little extra salary, be one capable of starting and stopping a diesel engine for these daily runs, so that the labor charge for the generation of this peak-load current would be practically nothing. In larger communities supplied under the same general system and requiring a larger diesel installation for their emergency and peak-load needs, conditions would still permit the operation of the diesel plant with small additional labor expense. There is usually a storehouse and shop as well as a sub-station, and if combined with the diesel-engine station, this will help to reduce attendance and overhead charges.

The transmission system, including transformers, could be smaller and cheaper than for serving the communities without the diesel-engine peak-load station. The main central-station plant could be smaller and could be designed as a true base-load station, thus giving the utmost efficiency possible.

For each outlying diesel peak-load station with, say, a single 500-kw. unit, the central-station-plant capacity could be decreased 625 kw., but it might not be deemed desirable and safe to cut off this capacity entirely. However, it would be reasonable to allow some reduction in both central-station capacity and line capacity on account of this outlying peak-load station. It might reasonably be expected that there could be a reduction of 400 kw. in station capacity amounting to $32,000 and a reduction of 400 kw.a. in line capacity amounting on a 30-mile, 33,000-volt line, including transformers, to about $8,000,000.

The cost of the installation of a 500-kw. diesel peak-load station will be approximately $108 a kilowatt.

The total production cost, not including fixed charges, management expense, or local distribution will be less than 8 miles per kilowatt-hour.

There are other advantages very much worth considering. If this idea is fully carried out, the main station becomes a purely base-load station, with its efficiency very greatly improved and the liability of outages greatly decreased, both of the station and the transmission system, due to the absence of daily peaks which are usually carried in part on the overload capacity of the system. The line and transformer losses are cut down considerably, and their reliability is also increased, for the same reasons. The customers in the community where the diesel peak-load station is situated obtained better-maintained voltage and greatly reduced interruptions to service, and also there is a feeling of much greater satisfaction, due to their knowledge than they have a plant running in their own community. Even though the plant is shut down every day during light-load periods, its presence, with its daily operation, creates a good feeling that seldom exists in a community served entirely from a distance.

The size of the diesel peak-load station and its daily operating period should be fixed only after consideration of several factors, namely, the low, average, and peak loads of the community served and their relation to the capacity of the main central station when operating as a base-load plant, the length and efficiency of the transmission line connecting them, the probability of increased load in the vicinity of the peak-load station, and the location of this peak-load station, as to whether it is on a single line or interconnected through a loop or ring system with other similar peak-load station within reasonable distance.

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United States Uses 95% of Natural Gas, Report Shows

THE UNITED STATES consumed in 1929 and is probably now consuming approximately 95 per cent of the entire natural-gas supply of the world. The enormous increase in the production of natural gas during the past eight years and the rapid extension of pipe lines for carrying the gas during the past three years, constitute one of the industrial marvels of the age.

In an intensive study by the research staff of the National Industrial Conference Board, to be published in a forthcoming report entitled "Competitive Factors in World Energy," all the available facts regarding natural gas development have been gathered. A picture of unparalleled development is presented, a development that may lead to profound changes in the production of power and in the position of coal and water power as sources of energy.

The expansion of consumption from 481 billion cubic feet of natural gas in 1909 to 1,918 billion cubic feet in 1929 is but one of the features of this remarkable development. In 1909 natural gas was used for power, heat and light only in the territory adjacent to the gas wells. At the present time pipe lines many hundreds of miles long are in use or under construction, and natural gas is being carried into hundreds of communities hitherto entirely dependent on coal or oil.

"The phenomenal expansion in the long distance transportation of natural gas that has taken place in the last three years," states the Conference Board report, "centers in three important areas. These areas are: the Monroe-Richland fields of Northern Louisiana; the Texas Panhandle and Hugoton, Kansas, fields; and the Kettleman-Buttonwillow fields of California. Fifteen or more great gas lines extend from these fields and will carry natural gas competition to markets from 200 to over 1,000 miles distant. This entry into markets formerly held by coal or fuel oil is intensifying fuel competition and may result in price wars."

Construction Industries Organize to Meet Problems

NINETEEN GROUPS of the construction industry, with more than 100,000 members, and representing billions in capital, have formed an alliance "to cooperate for the common good of the industry and better to serve the nation," it is announced by the American Institute of Architects.

Robert D. Kohn of New York, president of the Institute, has been chosen general chairman of the provisional organization, which will be known as the Construction League, and the scope of which embraces a vast army of workers, including the Building Trades Department of the American Federation of Labor. The League will be incorporated in the District of Columbia, and will maintain headquarters in Washington. The number of member associations will eventually be increased to 35.

Other officers have been named as follows: First vice-chairman, Francis L. Stuart, president of the A.S.C.E.; second vice-chairman, A. P. Greensfelder, president of the Associated General Contractors of America; treasurer, H. H. Sherman, president of the Producers' Council; general secretary, P. W. Donoghue, president of the National Association of Master Plumbers.

"An effort is to be made to create a medium for coordinated action within the building industry," said a statement by Mr. Kohn outlining the purposes of the League. Matters of great moment to the entire building industry are under way. Some are being promoted by the architects, others by the contractors, and still others by a score or more important professional or trade organizations of the industry. Each is being carried on with very little, if any, support from the other groups.

"The consensus of opinion plainly is that the industry as a whole is ready to follow the leadership of the professional men, and that the various contractor and trade organizations realize the need of professional leadership.

"The League, it is believed, should do nationally what has been done in many cities by local building congresses. Many constructive policies are being carried out, but need coordination. These include the apprenticeship work of the building congresses, the movement for better quality in building materials fostered by the Producers' Council, and the attempts by the Associated General Contractors to bring about the pre-qualification of bidders, and to relieve the unemployment emergency.

"Reforms of importance to architects and engineers are being promoted by the associations of plasterers, sheet metal workers, marble quarrymen and dealers, painters, and heating and piping contractors. Another significant program is that of the Electrical Guild of America embracing education, old-age pensions for workers and unemployment insurance investigations."

FROM AMONG READERS' PROBLEMS

Conducted by

L. H. MORRISON

CAPACITY OF REFRIGERATING COMPRESSOR—*What is the capacity of a 2x2-in., twin, single-acting methyl chloride compressor operating at 350 r.p.m., with 2 lb. gage suction and 75 lb. gage discharge pressure?* R.H.R.

The volume of gas handled by the compressor is, of course, the piston displacement times the volumetric efficiency, which latter should be around 65 per cent.

The piston displacement in cubic feet per minute is then

$$\frac{0.7854 \times D^2 \times S \times \text{r.p.m.} \times \text{No. of cylinders}}{1728}$$

Subsituting the values given,

$$\frac{0.7854 \times 2 \times 2 \times 2 \times 350 \times 2}{1728}$$

$= 2.55$ cu.ft.

With 65 per cent volumetric efficiency the actual volume handled is $2.55 \times 0.65 = 1.657$ cu.ft.

At 2 lb. gage suction pressure a pound of methyle chloride has a volume of approximately 5.47 cu.ft., consequently the compressor handles $\frac{1.657}{5.47}$ = 0.3 lb. per minute.

At 75 lb. head pressure a pound of liquid methyl chloride contains approximately 57 B.t.u. At 2 lb. gage the gas contains approximately 196 B.t.u. per pound. The difference, 196 — 57 = 139 B.t.u, is the refrigeration effect per pound. The compressor handles 0.3 lb., so the machine's duty is $139 \times 0.3 = 41.7$ B.t.u. Since a ton of refrigeration is the removal of 200 B.t.u. per minute, the machine has a duty of

$$\frac{41.7}{200} = 0.208 \text{ tons.}$$

In ice melting effect it is equivalent to

$$\frac{41.7 \times 60 \times 24}{144} = \frac{60040}{144}$$

= 417 lb. of ice per day.

DETECTING CRANKSHAFT CRACKS — I *have lately had an experience with a high-speed engine breaking its crankshaft which was of the overhung, or single-crank, construction shown in the sketch. At the time the engine was running 230 r.p.m. with 145 lb. steam pressure and was carrying full load. The engine was nearly a complete wreck.*

The break occurred just inside the boss of the crank web where the sharp corner was made by reducing from 7⅞ to 5½ in. with almost no fillet left in the corner.

As there are several of these engines in use and presumably of like construction, it is a matter of interest to know if there is any known way to discover the existence of a crack developing at this point, where it would seem to be almost impossible to discover one by any of the usual means of inspection. Would it be best to install a new crankshaft with crank disc fitted full size on suspicion that a crack might be developing? Almost any expense to avoid such a smash would be real economy in the long run. C.B.S.

The cheapest way to ascertain if cracks exist in the other engine shaft is to heat the disk and then remove it. If the shaft be coated with a mixture of white lead and oil, which is then wiped off before drying, the lead which has entered the fractures, will show faint white lines on the steel surface.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

Our boiler plant contains two stoker-fired 6,000-sq.ft. boilers which normally operate close to their capacity during an 8-hr. weekday. Shortly after the first of the year new equipment in the factory will demand about 7,000 lb. of steam per hour more than the boilers can produce at present for a period of about two hours each day. How can the capacity of our steam-generating plant be increased to meet this additional load without installing new boilers? L.G.M.

THE DATA given on these boils is insufficient to allow any direct solution, so a general discussion as to the more common methods of increasing the output of a boiler is given.

The two boilers mentioned should evaporate approximately 36,000 lb. of water per hour at rating. If they are run at 200 per cent rating at present, the requirements are for only a 10 per cent increase in output. This appears to be rather a small additional demand.

If the limit of their capacity is determined by excessive furnace maintenance it would be well to investigate other available types of coal in that vicinity with the possibility of increasing the output with the adoption of a different coal.

Nothing is said as to the condition of the boiler tubes or baffle walls, or about the draft, CO_2 and the flue temperatures. The first two are purely matters of proper operation and maintenance while the last three call for metered combustion. This may also be classed under proper operation as it is impossible to operate boilers of this size and obtain the highest efficiencies without recording meters in good working order.

Assuming the furnace design to be correct the furnace volume will be an important factor, for if it is in correct proportion to the heating surface a higher heat release per unit volume should be attained by increasing the air-fuel rate in proper ratio. This will call for more air but as nothing is said regarding the draft equipment there may be different methods of accomplishing this, such as installing a fan, increasing the fan speed, or adding to the height of the stack.

No figures were given on the feed water temperature. If this is not at least 50 per cent of the saturated steam temperature and space is available, the capacity of the boilers could be increased considerably by the installation of an economizer. As considerable steam is required for process this would allow the motorizing of most auxiliaries and heating the feed water by waste heat in the breeching. H. M. SPRING.

Milford, Del.

THE STEAM CAPACITY of the plant might be increased in several ways, of which the correct one could be better recommended if the type and condition of some of the plant equipment were known. One method which usually brings the desired results, is to change the kind of fuel and the manner of firing in order to increase the B.t.u. liberation per cubic foot of furnace volume and, consequently, the percentage of boiler rating. There is one interesting possibility, however, which is peculiarly adopted to the specified requirements.

A steam accumulator with a 20-hr.

charging capacity and of sufficient capacity to carry the two-hour peak load of 7,000 lb. of steam per hour could be installed. The two-hour peak load on the accumulator would take 14,000 lb. of steam, which would call for an accumulation input of 700 lb. per hour during the off-peak period. There is little available published data on the cost of steam accumulators, but a figure of $0.70 per pound of steam of maximum discharging capacity should cover the cost of material and installation, including the necessary valves and piping. This gives about $10,000 as the first cost of an accumulator plant large enough to carry the required load.

There are more advantages in this arrangement than merely carrying the overload on the present plant. The boiler pressure and steam temperature are kept freer from minor fluctuations with the accumulator floating on the line. This factor is often of importance in process work, besides the consequent fuel saving effected. For a complete analysis and study of industrial power plant operation with and without accumulators, reference is made to a paper presented by R. A. Langworthy before the A.S.M.E. in 1928, and published in Vol. 50, No. 15 of A.S.M.E. Trans.

ALFRED W. FOX.
Rochester, N. Y.

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THE PRESSURE at which the boilers operate and the pressure at which the additional 7,000 lb. of steam per hour are required is not given. However, during a period of two hours each day the plant must be supplied with 14,000 lb. of steam in addition to what the boilers can generate during that period.

One way of obtaining this extra steam is to add a steam accumulator to the plant. In order to illustrate the action let us suppose that at the beginning of the two-hour period the accumulator is full of water at 95 lb. absolute pressure. The steam is assumed to be required for process work at 55 lb. absolute pressure. Enough water must be stored at 95 lb. to contain sufficient heat to cause 14,000 lb. of water to flash into dry steam at 55 lb. when the pressure is gradually reduced.

Let X equal the amount of water at 95 lb. Its heat content will be 294.5 B.t.u. per pound. When the 14,000 lb. of steam have been withdrawn there will be left in the accumulator $(X - 14{,}000)$ lb. of water at 55 lb. abs., having a heat content of 256.3 B.t.u. per pound. The steam drawn out at 55 lb. will have a heat content of 1175.4 B.t.u. per pound. Setting this up as an equation on the basis of the total heat in the water at the start being equal to the total heat in the water at the end plus the heat content of the steam withdrawn we have $294.5\ X = 14{,}000 \times 1{,}175.4 + (X - 14{,}000)\ 256.3$.

Solving: $X = 337{,}000$ lb. of water.

At 95 lb. abs. water weighs 57.75 lb. per cubic foot, therefore the volume must be 5,840 cu.ft.

The accumulator should be covered to reduce radiation but there will be some unavoidable heat loss and to allow for this a volume of 6,000 cu.ft. should be provided. A greater pressure range will permit of a smaller accumulator volume.

By operating the boilers about 20 min. longer each day the necessary heat can be stored in the accumulator. Perhaps the load fluctuation is sufficient so that by operating the boilers at capacity continuously for the eight hours enough steam over and above the plant demand can be obtained to charge the accumulator.

WALACE H. MARTIN.
Corvallis, Ore.

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TO ANSWER the question requires a knowledge of the limiting factors. Neglecting such obvious ones as lack of draft, wet steam, it will be assumed that it is the inability to burn more fuel, that is, insufficient stoker capacity. It is necessary, therefore, to get more output from the fuel, and this means an increase in heat absorbing surface, or the addition of water walls, tubes, air preheaters, or economizers. By lowering the exit temperature of the gases, we increase the efficiency and thus get an increase in output from the same amount of fuel burned.

Usually the cheapest and best method in an existing plant is to install economizers, as these require fewer changes and cost less for a given increase than do the other methods. The amount to install and the required additional heat can be quickly calculated, if we make a few assumptions.

Let us assume that the present maximum output is 100,000 lb. of steam per hour (250 per cent rating) and that the steam has a total heat of 1,200 B.t.u. at 240 lb. abs. pressure, and the feed water enters at 212 deg. Then the heat absorbed by the boilers is $100{,}000 \times (1{,}200 - 180) = 102{,}000{,}000$ B.t.u. per hour. As we need 107,000 lb. of steam, the boilers need only add $\frac{102{,}000{,}000}{107{,}000} = 955$ B.t.u. per lb. of steam. Therefore the entering feed water must be raised $1{,}020 - 955 = 65$ B.t.u. or to a temperature of 277 deg. F. The induced draft fans, however, will require some power, and if steam driven, some steam. Consequently, it would be well to choose an economizer large enough to raise the feed water another five degrees, a total rise of 70 deg. Without going into details, an economizer having about 5,550 sq.ft. heating surface, 5.5 B.t.u. heat absorption rate, will give a 70 deg. increase in feed water temperature, dropping the exit gases 147 deg., provided the pounds of gas per pound of water ratio is 2, a probable ratio of this rating.

Cleveland, Ohio. THEODORE MAYNZ.

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THIS QUESTION will have to be answered in a general way because the information given is too meager to go into details.

The 7,000 lb. additional steam per hour will cause an increase in load of 16.9 per cent on the two boilers should they be operating at only 100 per cent of rating; 11.2 per cent increase at 150 per cent of rating and 8.4 per cent increase at 200 per cent of rating. It seems reasonable to believe the boilers should be operating at 150 or 200 per cent of rating, and with an increase in load of only 11.2 per cent and 8.4 per cent respectively, attention to a few details should accomplish the desired result as there is still some boiler capacity available.

The following will aid in handling the added load: Increase the feed water temperature, maintain the CO_2 at the highest point the design of the furnace will permit and without showing more than a trace of CO, give close attention to the fire and operate it to get the maximum fire considering the coal used and change to a higher grade coal if necessary. No matter how efficient we operate, we can always do a little better. An additional forced draft unit may be necessary or speeding up the old one may suffice, with a corresponding increase in stoker speed. Should the stack draft not permit of any additional load, the installation of an induced draft fan will help or, possibly only a re-design of the breeching or parts of it will be necessary. Testing the draft at the boiler outlet and at the stack will tell if the loss is greater than it should be.

If everything possible has been done already to increase the capacity of this boiler plant similar to this outline, the use of a steam accumulator suggests itself. This is, of course, dependent on the use of a pressure in the factory appreciably lower than the boiler pressure. As the pressures can be given.

Austin, Minn. ELMER N. ANDERSON.

A Question for Our Readers

WHEN OPERATING *a low-head multi-spray jet condenser, where should the water level in the casing be kept, that is, how far below the vacuum breaker float chamber?* C.B.

Suitable answers from readers, if received promptly, will be paid for[1] when published.

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[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

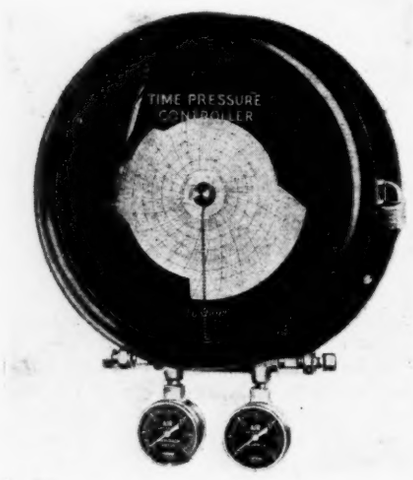
Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

WHAT'S NEW IN PLANT EQUIPMENT

Non-Recording Time Controller

AN INSTRUMENT for controlling temperature or pressure in relation to time, known as the non-recording time controller has been developed by the Foxboro Company, Foxboro, Mass. The controller is designed to maintain a predetermined cycle of operation in any process involving temperature or pressure.

The instrument is similar in appearance and construction to the standard Foxboro recorder-controller except that the non-recorder has a printed aluminum cam instead of a paper chart and a specially designed cam follower in place of the pen arm. This construction has made it possible to obtain a 1 to 1 ratio between the cam reading and control point setting, thus maintaining the control point without the use of multiplying devices.



Foxboro time controller

The controller is designed for use on industrial processes in which the relation of time to temperature or pressure is important. In the controlling of gas pressure, for instance, it is used in conjunction with a diaphragm motor controlled valve, to build up or let down the pressure in the line according to previously determined load conditions.

Improved Manhole Gasket

THE ACCOMPANYING illustration shows a section of the improved manhole gasket now being put out by the Flexitallic Gasket Company 8th & Bailey St., Camden, N. J. The new gasket is made up of alternate metal and asbestos

Section of Flexitallic manhole gasket

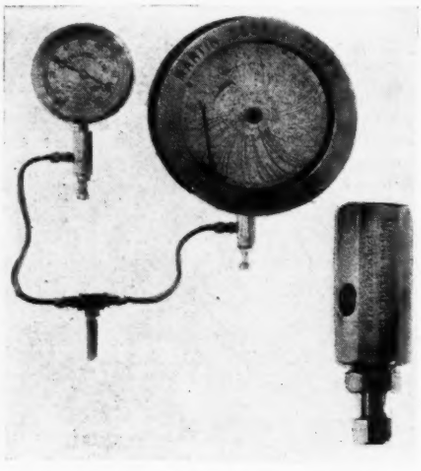
rings as shown, with double thickness of metal on the inner and outer circumferences as well as at two intermediate points. The metal strips have a V-shaped spring-like crease lengthwise and when the gasket is wound the V-shaped crease in the strip locks with the crease in the previous strip at the same time securing the turns of asbestos between the rings of metal.

The inner and outer rings of the gasket are crimped to secure them in place and the intermediate reinforcing rings insure the gasket against spreading under pressure and reduce the strain on the outer pieces of metal. The gasket can be furnished with metal strips of steel, monel, copper, aluminum, bronze or stainless steel.

Gage Pulsation Dampener

ADJUSTABLE in one size for any pulsating pressure from a few inches of water to several thousand pounds, the pulsation dampener recently introduced by the Martin-Decker Corporation, 3431 Cherry Ave., Long Beach, Calif., is designed for use on indicating and recording gages, on orifice meters, draft gages, low-pressure manometers and other types of pressure-measuring instruments and pressure-operated devices. It can be used on air, gas, oil, water, steam or gasoline.

The dampener is less than 4 in. long and 1½-in. in diameter. Installation can be made in any position. It is made in two models, brass body with stainless-steel stem, and all-stainless-steel.



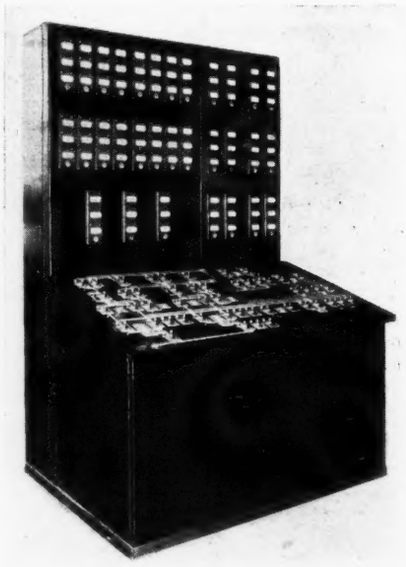
Dampener fitted to indicating and recording gage

Desk Type Miniature Switchboard

TO PROVIDE centralized control for generating stations and substations so that they can be more conveniently controlled, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed a line of miniature switchboards. The production of these small, centralized control boards has been made possible by the development of a complete line of miniature switchgear devices for this specific application.

The switchgear devices include new control switches (Minatrols), indicating lamps of the new Minalite design and the Type "V" line of instruments.

These miniature switchboards are designed for two classes of service: for local control of generating plants and substations, and for control over extended distances by means of telephone cable. In addition, miniature switchboards are suitable for centralized industrial control, where it is necessary to place the control of a large number of manufacturing or process units under the direction of one operator. The functions are essentially the same as the conventional switchboard, consisting mainly of circuit breaker controls and indications, provisions for synchronizing, control and indication of electrically operated disconnecting switches, transformer tap changers, voltage regulators, etc.; protective relay operation indication; bell and lamp alarm signals; and metering indications of current.



Miniature switchboard for an entire generating station

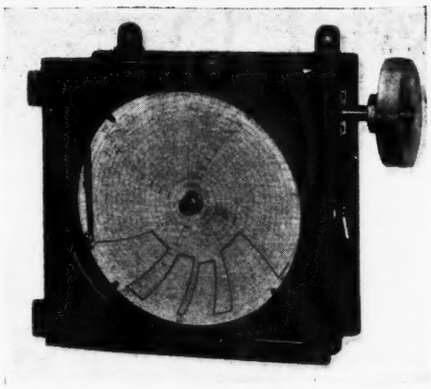


Chart records period of operation and shutdown

Operation Recorder

ALTHOUGH designed primarily to automatically record the time of operation and shutdown of a machine or unit in industrial plants, the operation recorder, developed by the Amthor Testing Instrument, Inc., 309 Johnson St., Brooklyn, N. Y., is applicable to a number of services in the power plant. These include recording the operating regularity of turbines and the correctness of the overspeed or safety trip, the recording of the rate and regularity of coal feed on stokers and speed of fans where the speed controls the amount of air delivered to the furnace, as well as a number of other uses.

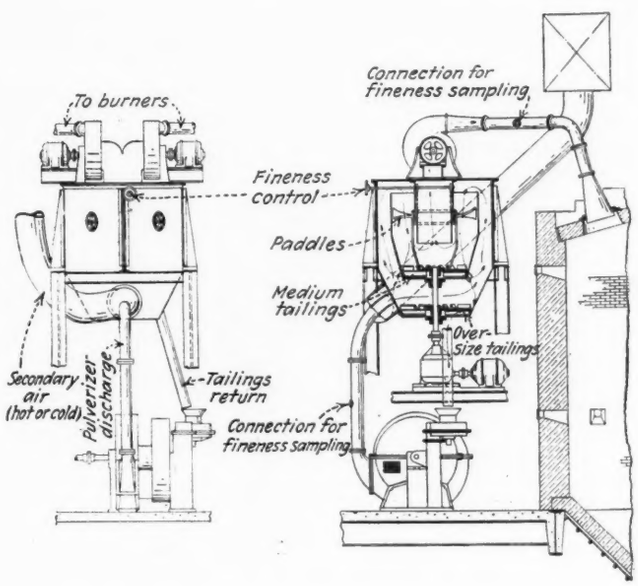
The recorder movement is essentially a centrifugal governor with the motion of the governor transmitted directly to the pen arm by connecting links. The standard clock movement is used to drive the chart, giving a 12 or 24 hour record as specified. The instrument is constructed with drive on either side or back as desired and for use with either belt, coupling or flexible-shaft connection. It can be operated in either direction and is said to be independent of temperature change or magnetic influence.

Mechanical Cyclonic Separator for Pulverized Coal

INCREASED pulverizing capacity, uniform fineness of product regardless of wear on pulverizing elements and reduction in horsepower per ton of finished material are said to be possible, through the use of the air separator or classifier illustrated, in connection with a coal pulverizer of the air separating type. The classifier is installed between the mill and burner and is operated as a self-contained unit.

With the classifier in the circuit the mill is fed to capacity regardless of fineness, with just enough air through the mill to transport the material, fine and coarse, into the bottom of the classifier. Secondary air, either hot or cold, is admitted to the separator at the same point. The extreme coarse particles drop out of the air current in the lower portion of the separator and are returned to the mill. The primary air from the mill and the secondary air currents carry the medium and fine particles of coal upward between the outer shell of the separator and an inner drum, passing over the top into the inner shell as indicated by the arrows. At this point the air and material are brought into contact with a series or revolving paddles which throw the material outward and downward. The air currents at this point are drawn toward the center by the fan, or fans, mounted on the top of the separator and the cyclonic action thus produced throws the coarser particles downwards to a revolving disk from which they are discharged to the mill feed hopper for further grinding. The fine particles are carried through the fan at the top of the separator to the burner at the boiler furnace. The principal of the classifying action is atomizing the material centrifugally with an air current traveling cyclonically towards the center of the fan intake.

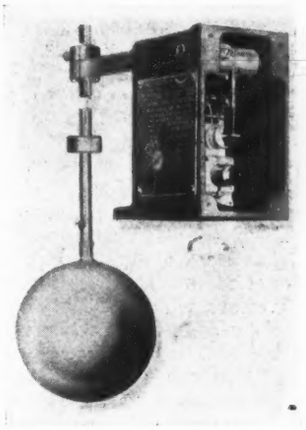
It is also pointed out by the manufacturer that the classification can be varied as desired with identical volumes of air passing through the separator. This is of importance since it permits the delivery from the mill of a rich or lean mixture of fuel and air, and a reducing or oxidizing flame can be produced at will. The unit is put out by the Mechanical Cyclonic Classifier Company, 900 E. Seventh St., Alton, Ill.



Separator is installed between mill and burner and is designed to give uniform fineness of product

Float-Operated Motor Starter

FOR SMALL alternating- and direct-current motors on sump pumps, open tanks and similar applications the new float-operated motor-starting switch announced by Cutler-Hammer, Inc., 294 No. 12th St., Milwaukee, Wis., provides across-the-line starting, thermal-overload protection, and is small in size. For larger motors this same device can be provided without overload protection so it can be used as a master switch in the control circuit of a separate automatic starter. It can also be furnished without the float accessories for use as a lever-operated master switch.



Starting switch for alternating and direct-current motors

It is a single-pole starter with double-break silver contacts. The operating lever and shaft are reversible in the case and the operating lever can be shifted to any angular position of the shaft, so that either tank or sump operation can be obtained with the starter mounted in any position.

Maximum ratings for this float-operated motor starter are alternating-current ½ hp., 110 or 220 volts, single-phase; direct-current, ⅓ hp., 115 volts.

Gear Lubricants

SULPHURIZED OILS and greases especially suitable for high-speed bearings, speed reducers and other gears, have been announced by D. A. Stuart & Company, 2727 South Troy St., Chicago, Ill. The lubricants, which are known as S.A.E. extra pressure lubricants and are available in either oil or grease form, range in viscosity from s.u. 100 sec. at 100 deg. F. to 350 sec. at 210 deg. F. with a pour test for the lower viscosities as low as minus 40 deg. F.

NEWS of the FIELD

American Engineering Council Enlists Aid of 100,000 Engineers in Plan to End Depression

PLANS to mobilize the nation's engineers behind President Hoover's program to end the depression were announced last week by the American Engineering Council. The aid of more than 100,000 engineers will be enlisted in a movement to increase and to stabilize employment, and to prevent the adoption of unwise legislation, federal, state, or municipal.

The council will work with the relief organization set up by the President under the headship of Walter S. Gifford, president of the American Telephone & Telegraph Company. The aim, it was said, is not only to promote emergency measures but to develop sound permanent employment policies throughout American industry.

F. J. Chesterman of Pittsburgh, vice-president and general manager of the Bell Telephone Company of Pennsylvania, has been appointed chairman of a national committee to direct the engineering effort, which will be carried out in detail by committees to be named in every state. These committees will cooperate with the industries and with civic and business bodies.

Other members of the national committee are: General R. C. Marshall, Jr., of New York, who was in charge of the construction division of the War Department during the World War; E. K. Ruth, American Oak Leather Company, Cincinnati; W. R. Webster, Bridgeport Brass Company, Bridgeport, Conn.

"The American Engineering Council," the announcement declared, "feels most emphatically that the immediate answer for unemployment is jobs; that the spreading of man-hours is the most essential expedient for stabilizing employment that can be suggested at the present time.

"There is a very pronounced feeling that industry and commerce are largely responsible for the perplexities which have arisen, and that they should provide a satisfactory solution. This thought is not confined to any so-called radical group, but it also prevails among fair-minded, far-seeing men and women.

"They realize that unless industrial and commercial leaders successfully deal with the problem of unemployment in permanent fashion that both the federal and state governments will very likely enact unemployment insurance laws. That such laws would be detrimental to the economic and social well-being of the nation is generally acknowledged. Whether this country escapes such consequences will depend entirely upon constructive leadership.

"The council also recognizes that engineers compose an important fraction of the industrial and commercial leadership of the nation; consequently they are in a position to make an essential contribution to the development of measures looking toward stabilization of employment throughout the economic fabric of the nation."

British Fuel Problems Discussed in London

AT A JOINT MEETING of the Institute of Fuel and eighteen other British technical societies, held in London Oct. 7, Dr. W. R. Ormandy presented a paper on "Coal: Smokeless Fuel and Oil From the National Standpoint."

After a brief account of the present overproduced conditions of the coal and oil industries, which he believes can reach a sane economic policy only through international agreement among producers and distributors, Dr. Ormandy took up the problem of converting coal into oil either directly by hydrogenation or by carbonization. He reviewed the technical advances that have been made and showed the possibilities of hydrogenation as a means of helping the coal industry. Pointing out that hydrogenation is a question of national economics, he stated that at present prices of oil and coal it would not pay but that other factors, such as the desirability of producing oil in England and the employment it would afford, might influence its adoption.

In describing the carbonization industries, Dr. Ormandy treated in detail the various aspects of the coke oven, low-temperature processes and the gas works, as well as the utilization of their products and byproducts. He sounded the note of growing sentiment against the smoke nuisance in his discussion of the problem of displacing bituminous coal for household purposes by a smokeless fuel, pointing out that the proper place for the development of smokeless fuel was the existing gas works.

In conclusion he discussed the position of the Fuel Research Division of

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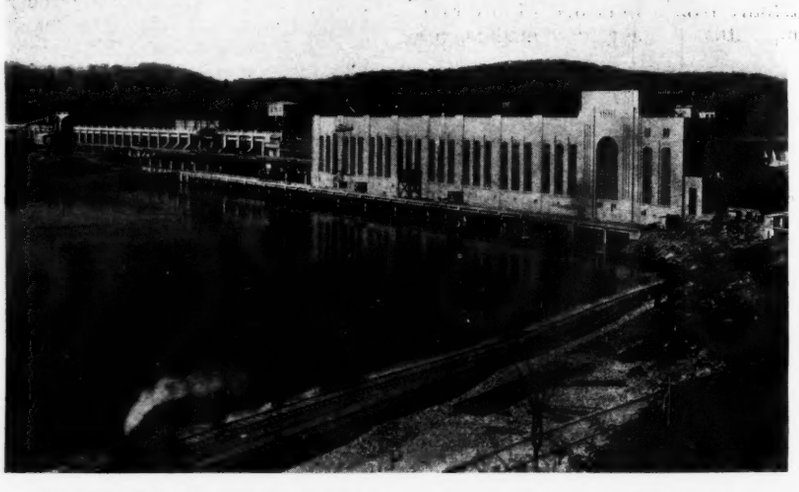
SAFE HARBOR NEARING COMPLETION



The new $30,000,000 hydro-electric development of the Safe Harbor Water Power Corporation on the Susquehanna River, now nearing completion, will have an initial capacity of 255,000 hp. and an ultimate of 510,000 hp. It is one of three plants that will serve the Pennsylvania Railroad's electrification to Washington, the other two being the 180,000-hp. steam and hydro development of the Pennsylvania Water & Power Company at Holtwood, Pa., and the 346,000-hp. station of the Consolidated Gas, Electric Light & Power Company of Baltimore.

the British Department of Scientific and Industrial Research. He could not agree with the criticisms of the division's work, and he advanced strong arguments to show the necessity for the existence of an organization such as the present one.

Start Negotiations on St. Lawrence Project

NEGOTIATIONS between the United States and Canada preliminary to drawing up a treaty for development of a great St. Lawrence River seaway were begun in Washington, D. C., on Oct. 12. W. D. Herridge, Canadian Minister, conferred at length with Under-Secretary William R. Castle, Jr., at the State Department.

The negotiations probably will take many weeks, if not months, as the project involves perplexing problems of disposal of power in addition to its navigation aspects.

Frozen Brine Heat Tables Issued by Standards Bureau

AMOUNTS of heat absorbed by frozen or partially frozen brine as it rises in temperature have been tabulated for the use of refrigeration plants by the Bureau of Standards, according to a statement issued Oct. 13 by the Bureau.

Refrigeration engineers have known how much heat will be used in warming cold brines, thus cooling the surrounding air proportionately, but they have not known how much heat is absorbed by frozen or partially frozen liquids, according to the statement.

As the result of a study of this subject at the Bureau of Standards methods have been developed for calculating the quantity of heat absorbed when one pound of a brine initially frozen or partially frozen is heated to any higher temperature. Using these methods practical working tables have been prepared.

Water Heating Boiler Explodes in Chicago

A HOT-WATER SUPPLY boiler serving the Lynch bathhouse at 5 North Clark St., Chicago, exploded on Oct. 3. Considerable property damage resulted, but there were no fatalities nor injuries.

It seems that a plumber had been at work on the heating system in the vicinity of the boiler. For some reason he had to confer with an employee in the bathhouse, and during his absence the boiler exploded.

No authentic information is available on just what happened, but the supposition is, that to work on the system it was necessary to close the valves in the line to the supply tank. With a fire under the boiler and probably a stuck safety valve, the pressure soon built up to the bursting point.

NEW HOME OF McGRAW-HILL

This week Power will move to its new home on the 30th floor of the recently completed McGraw-Hill Building, located in the heart of New York City at 330 West 42nd St. Besides the editorial, circulation, business and production departments of 34 publications of the McGraw-Hill Publishing Company, the new building will house the offices and sales room of the McGraw-Hill Book Company, the McGraw-Hill Catalog & Directory Company and various other affiliated interests

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Doherty Fund May Not Be Given, A.S.M.E. Announces

"SO MANY INQUIRIES have been received concerning the offer of $500,000 by Mr. H. L. Doherty for the financing of a plan to solve the unemployment problem, that it is desirable to make clear to the members of our society and others of the engineering profession, that the engineers have not received the $500,000 from Mr. Doherty and may not even receive it, "The American Society of Mechanical Engineers announced Oct. 20.

"In pursuance of his consistent interest in the stablization of employment, President Wright followed his plan of allowing no opportunity to remain uncovered in which the public might realize the great advantages from investigation and research as planned by the engineers of the American Engineering Council, and sponsored by its constituent bodies.

"A garbled report of Mr. Wright's words was published in a Kansas City newspaper and Mr. Henry L. Doherty made them the occasion for a statement that he would supply $500,000 to the engineers, and in fact unlimited support, if you (the engineers) will produce anything even promising. . . . Accordingly steps were taken to present to Mr. Doherty a carefully prepared statement of the plan which has been long under preparation and but recently completed by the American Engineering Council, and which President Wright had in mind when speaking at Kansas City. Details of this plan are being prepared for publication and will be available very shortly. Members of many of the local sections which President Wright has visited will clearly recall his advocacy of the proposed A.E.C. plan; indeed in many instances it was discussed at great length in the open forums which followed the address —and almost inevitably was most favorably received. In this sense President Wright may be said to have been speaking for the engineers as a whole in his Kansas City address, which did not differ materially in substance from the address made to many of the local sections.

"It must be admitted that all efforts to convince Mr. Doherty that the plan was worthy of receiving his finnacial assistance have definitely failed. In the last analysis Mr. Doherty's original telegram offering the $500,000 clearly left to him and men of his selection the judgment as to whether the plan warranted the expenditure. He has concluded that it does not. In all frankness it should be stated, however, that certain specifications were set up by him which, to all practical purposes, are unattainable.

"In the meantime, it should be pointed out that this conclusion has not in any sense altered the fact that the engineers' plan has received the indorsement of a large number of prominent engineers and industrialists. The American Engineering Council is proceeding with its presentation to other groups and is greatly encouraged with the progress being made."

Business Management Course Opens in New York City

The Bureau of Personnel Administration, New York City, started on Oct. 15 its Thursday evening course series, consisting of 25 conferences on "Business Management as a Human Enterprise."

The course is the tenth the bureau has offered on problems of business management. The objects of these conferences are, through research, discussion, and publication, to develop for the common benefit of employers, managers, workers, and society, integrated thinking and constructive direction of the basic principles of business administration and management. Each series is printed in volume form.

"Business Management as a Human Enterprise," like the preceding series, represents an earnest attempt to bring to business executives the point of view of specialists in the varied phases of the subject. The conferences are designed for business organizers and managers; factory, office, and sales executives; personnel directors; research specialists; social workers; and professional groups interested in management.

The conferences are held at the Engineering Societies Building on Thursday evenings, from 6 to 7:30 o'clock.

Southern Calif. Edison Adopts Five-Day Week

ALL DEPARTMENTS of the Southern California Edison Company are now on a five-day week schedule with corresponding pay adjustments, according to a statement made by John B. Miller, chairman of the board, in a letter sent out to holders of the preferred stock of the company Oct. 15. The completion of several of the larger construction projects of the company and the general slowing down of business were given by Mr. Miller as reasons for adoption of the new schedule.

Obituary

CHARLES L. HEISLER, inventor and designing engineer in the mechanical engineering department of the General Electric Company, died on Oct. 13 at his summer home in Rock City Falls, near Schenectady, N. Y. Mr. Heisler, who was born in 1863 at Wapakoneta, Ohio, worked virtually his entire life at designing and inventing. The list of Heisler inventions includes a geared locomotive, steam road rollers, waterworks pumping machinery, barometric condensers and a wet-type vacuum pump. He also was responsible for a dozen or more inventions, including appliances, reversing gears and pulverized-fuel feeds, for the American Locomotive Company. With the coming of the World War he developed devices for manufacturing shells and ammunition. Later he was mechanical engineer for the Washington Steel and Ordnance plant. He was a member of the American Society of Mechanical Engineers.

ANDREW J. WILEY, consulting engineer for the Hoover Dam project in Boulder Canyon since 1929, died on Oct. 8 in a hospital at Montrovia, Calif., following a cerebral hemorrhage. Mr. Wiley passed virtually his entire life in power, irrigation and dam projects in the West. He was born at New Castle, Del., in 1862 and was educated at Delaware College, Newark, N. J. He started his engineering career on various surveying and construction works of the Baltimore & Ohio Railroad, but in 1883 went to Idaho as assistant engineer in the construction of an irrigation system. Since that time he worked on various projects in California, Idaho, Wyoming, Arizona and Utah. Mr. Wiley was a member of the American Society of Civil Engineering and the American Institute of Consulting Engineers.

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Kansas City, Mo., Oct. 22-24. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

National Association Practical Refrigerating Engineers. Annual convention and exhibition at the Municipal Auditorium, Houston, Tex., Nov. 10-13. Secretary, Edward H. Fox, 435 North Waller Ave., Chicago, Ill.

Stoker Manufacturers' Association. Fall meeting at the Seaview Golf Club, Absecon, N. J., Oct. 26-28. Secretary, W. V. McAllister, Foot of Walker St., Detroit, Mich.

Seventh Annual Conference on Welding, to be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec. 10-11. Professor in charge, W. A. Knapp, Engineering Extension Department, Purdue University, Lafayette, Ind.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Personals

DWIGHT P. ROBINSON has resigned as president of United Engineers & Constructors, Inc., and EDWIN M. CHANCE, who was vice-president, has been selected to succeed Mr. Robinson, it was announced by the company last week. The announcement stated that Mr. Robinson had resigned after completing the work of coordinating the activities of the company with those of the United Gas Improvement Contracting Company, Day & Zimmermann Engineering and Construction Company, Public Service Construction Company and Dwight P. Robinson & Company.

FRANK B. ROWLEY, professor of mechanical engineering and director of the experimental engineering laboratory at the University of Minnesota, has been nominated for president of the American Society of Heating and Ventilating Engineers for 1932. Other nominees are W. T. JONES, of Barnes & Jones, Boston, Mass., for first vice-president; C. V. HAYNES, vice-president and general manager of the Hoffman Specialty Company, New York City, for second vice-president; and FREDERICK D. MENSING, consulting engineer of Mensing & Company, Philadelphia, Pa., for treasurer.

RALPH N. ROBERTSON, until recently chief mechanical engineer of the Blaw-Knox Company, Blaw-Knox, Pa., has become affiliated with the Atwood Bradshaw Company, Pittsburgh, Pa.

DR. D. B. STEINMAN, of New York City, was elected president of the National Council of State Boards of Engineering Examiners at the twelfth annual convention of the council, held in Detroit, Mich., Oct. 1 to 3. The other officers elected are N. T. KINZLY, of Nashville, Tenn., vice-president, and T. KEITH LEGARÉ, of Columbia, S. C., secretary-treasurer.

DR. GEORGE B. KARELITZ, formerly manager of the mechanics division of the Westinghouse Research Laboratory in East Pittsburgh, Pa., has been appointed division engineer in charge of transportation at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company. His new duties will include the supervision of the manufacture of marine apparatus, diesel engines and other equipment. R. E. PETERSON, research engineer, has been named to succeed Dr. Karelitz as manager of the mechanics division.

C. QUINCY IVES, formerly chief engineer of the Widger & Miller Company of Boston, was recently elected president and treasurer of that company to fill the vacancy occasioned by the resignation of T. S. WIDGER.

J. P. MCRAE, of Toronto, Ont., has incorporated the firm of McRae Engineering Equipment, Ltd., of which he will be president and general manager.

Business Notes

RILEY STOKER CORPORATION, Worcester, Mass., announces the following new appointments to its sales organization: F. E. Fleming has been appointed sales engineer at the Chicago office; R. L. Sauer has been made district manager at the Detroit office; M. L. Cornelious has been appointed district manager at the Cleveland office; I. W. Lachman is now sales engineer in the New York office; and W. J. Ehmer has been made sales engineer at the Philadelphia office.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that Harry L. Erlicher, who entered the employ of the company some twenty years ago as an office boy in the purchasing department, has been appointed purchasing agent to succeed L. G. Banker, who retired Oct. 1 after completing 43 years of continuous service with the company. Since 1923 Mr. Erlicher has been assistant purchasing agent. In his new position he will direct purchases of materials aggregating more than $100,000,000 a year.

CHICAGO PNEUMATIC TOOL COMPANY, New York City, announces the removal of its office and service station in Seattle, Wash., from 1743 First Avenue South to 3201 First Avenue South. C. Kirk Hillman has been appointed district manager at the Seattle office, and the company states that the new, larger quarters will permit carrying a complete stock of repair parts as well as representative items of its products.

TIMKEN ROLLER BEARING COMPANY, Canton, Ohio, announces that F. J. Griffiths has been elected director and president of the Timken Steel & Tube Company, and M. T. Lothrop, president of the Roller Bearing company, has been made chairman of the board of the Steel & Tube company. Until recently associated with the Republic Steel Corporation as president of the Republic Research Corporation, Mr. Griffiths has been prominently identified with the steel industry for the past 30 years.

MCCLAVE-BROOKS COMPANY, Scranton, Pa., announces the appointment of the Whitmore Company, 749 Harrison Ave., Scranton, Pa., as sales and service representative for the Scranton district territory, which includes twenty-one counties in Pennsylvania and four counties in New York.

WESTINGHOUSE ELECTRIC ELEVATOR COMPANY, East Pittsburgh, Pa., announces that it has just been awarded the contract for the supply of fifteen elevators for the new ten-story United States Parcel Post Building, which covers an entire block between Ninth and Tenth Aves. in New York City. The contract totals $248,735 and covers nine freight elevators with a capacity of 8,000 lb. each and a speed of 200 ft. per minute, and six passenger elevators of 2,500 lb. capacity at 600 ft. per minute.

How's Business?

BASIC COMMODITY prices have apparently stabilized at bottom levels, while retail prices rapidly recede, according to *The Business Week*, Oct. 21. Employment shows some seasonal expansion, merchandise freight movement has risen to meet holiday requirements, while steel demand has quickened slightly from scattered sources. Our index has shown reassuring resistance to further decline since August. The continuous succession of shocks during the past two years has apparently hardened the nervous system of American business against bad news and developed immunity to further disturbance from foreign political and financial forces. On the rock bottom basis of domestic needs it is beginning to rebuild a more stable structure.

Production of electricity by public utilities for the week ended Oct. 10 was 1,653,369,000 kw.-hr., a decrease of 4.1 per cent below N.E.L.A. figures.

Trade Catalogs

PULVERIZERS — The Whiting table roller improved Bethlehem pulverizer is described and illustrated in Bulletin No. 12 recently issued by the Grindle Fuel Equipment Company, a subsidiary of the Whiting Corporation, Harvey, Ill. This machine may be used for pulverizing coal, blast furnace slag, paint, pigments, rock, talc, clay, bentonite and other miscellaneous materials.

STOKERS — "Burning Fourth and Fifth Vein Indiana Coal Successfully With Stokers" is the title of a new bulletin summarizing a series of tests made at Purdue University, which is being distributed upon request by the Joseph Harrington Company, a subsidiary of the Whiting Corporation, Harvey, Ill.

FEEDWATER TREATMENT—The action of "Pamolene" in the prevention and removal of scale in boilers is described in a booklet entitled "The Colloidal Treatment for Boilers," recently published by the Feedwater Treatment Corporation, 123 Heath St., Boston, Mass.

INSTRUMENTS — Latest developments in the company's line of electric flow meters are featured in illustrated Catalog No. 2002 published by the Brown Instrument Company, Wayne & Roberts Aves., Philadelphia, Pa. Among the new products are a low-range manometer and a high-pressure flow-meter manometer. Another recent publication of the company explains and illustrates the principal features of new Brown potentiometer pyrometer.

PROTECTIVE COATINGS—"Special Protective Coatings for Industry" is the title of a new bulletin (No. 505) issued by the Wailes Dove-Hermiston Corporation, 17 Battery Pl., New York City, which gives full details on anti-corrosive coatings for the protection of underground and underwater surfaces and other structures subjected to extreme corrosive influence. This is the first publication of the company to give all essential data on the prevention of corrosion in the various industrial fields.

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Fuel Prices

FUEL OIL

Boston—Oct. 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.87c. per gal.; 28@32 deg., 4.83c. per gal.

New York—(Oct. 15) Industrial use, f.o.b. per barrel of 42 gal.: Bunker C 70c., terminal; Diesel, $1.40, refinery.

Tank-wagon delivery, per gal.: No. 1 (36@40 deg.), 8c.; No. 2 (32@36 deg.), 6.5c.

Philadelphia—(Oct. 14) Industrial use, f.o.b., per bbl. of 42 gal.: Bunker C, 70c.; Diesel, $1.40.

Tank-wagon delivery per gal.: No. 1, 7.5c.; No. 2, 6c.

Pittsburgh—(Oct. 14) f.o.b. local refinery, fuel oil, 36@40 deg., 2.5c.@2.75c. per gal.

Cincinnati—(Oct. 13) Industrial use, f.o.b. tank cars, per bbl. of 42 gal., $1.25.

Tank-wagon delivery, per gal., 6.5c.

Chicago—Sept. 28, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. of 42 gal.: 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5c. per bbl.; 28@30 deg., **37.5c. per bbl.**

St. Louis—Sept. 29, tank-car lots, f.o.b. St. Louis: 24@26 deg., $1.02 per bbl., of 42 gal.; 26@28 deg., $1.095 per bbl.; 28@30 deg., $1.195 per bbl.; 30@32 deg., $1.245 per bbl.; 32@36 deg., gas oil, 2.776c. per gal.; 36@38 deg., distillate, 3.151c. per gal.

Dallas—(Oct. 10) Industrial use, f.o.b., per bbl. of 42 gal., No. 6, 70c.

COAL

Bituminous	At Mine, for Shipment to	Price per Net Ton
Clearfield, mine-run	New York	$1.50@$1.75
Pittsburgh, mine-run	Pittsburgh	1.20@ 1.50
Pittsburgh, st. slack	Pittsburgh	.60@ .70
W. Ky., mine-run	Louisville	.85@ 1.30
W. Ky., slack	Louisville	.35
Fairmont, mine run	Fairmont	.90@ 1.10
Fairmont, slack	Fairmont	.50@ .85
Smokeless, mine-run	Cincinnati	1.75@ 2.00
Smokeless, slack	Cincinnati	.35@ .75
Kanawha, mine-run	Cincinnati	1.00@ 1.25
Kanawha, nut-slack	Cincinnati	.35@ .50
Smokeless, mine-run	Chicago	1.75@ 2.00
Smokeless, slack	Chicago	.40@ 1.00
Harlan, Ky., slack	Chicago	.60@ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.10@ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20@ 1.75
Standard Ill., mine-run	St. Louis	1.30@ 1.50

Anthracite	At Mine, for Shipment to	Price per Net Ton
Buckwheat	New York	$3.25
Rice	New York	1.75@ 1.85
Barley	New York	.90@ 1.40

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Alameda—Bureau of Public Roads, 461 Market St., San Francisco, is having plans prepared for the construction of unit No. 4, power duct lines in connection with improvements at Government Island here.

Calif., Covina—San Gabriel Valley Pre-Cooling & Ice Corp., preparing plans for the construction of a 2 story, 100 x 325 ft. pre-cooling plant including ice storage room, etc. Estimated cost $300,000. Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles, is engineer.

Calif., El Centro—City plans the construction of a sewage system including pumping plant, etc. Estimated cost $177,000. P. Knight is city engineer. Burns-McDonnell-Smith Engineering Corp., Western Pacific Bldg., Los Angeles, are consulting engineers.

Calif., Whittier—City, D. E. Allen, Clk., will soon award contract for sewage treatment works including pumping plant, screen house, etc.

Conn., Hartford—Trinity College, 1651 Broad St., awarded contract for a 1 story, 25 x 40 ft. addition to boiler plant to R. G. Bent Co., Inc., 93 Edwards St. Estimated cost $25,000.

Ind., Brazil—City plans the construction of a municipal light plant. Estimated cost $25,000.

Ind., Fort Wayne—Orphans Home, awarded contract for furnishing and installing three stokers to Economy Stoker Co., 2050 Phenie St.

Ky., Bowman Field — Constructing Quartermaster, will receive bids until Nov. 3 for the construction of air corps double hangar with annexes and boiler house annex. Appropriation $61,207.

Ky., Ludlow—City plans an election Nov. 3 to vote $120,000 bonds for waterworks improvements, including wells, pump house, pumps, softening plant, etc. Glazier & Morlidge, 305 Walnut St., Cincinnati, O., are engineers.

Mass., Bridgewater—Commonwealth of Massachusetts, Dpt. of Correction, plans the construction of a service building including refrigeration system at State Farm. Estimated cost $40,000. Architect not selected.

Mass., Gardner — Commonwealth of Massachusetts, Dept. of Mental Diseases, Boston, will receive bids until Oct. 27 for the construction of a power generating plant including turbines, boilers, stokers and switchboard at Gardner State Hospital here. Estimated cost $125,000 to $150,000. Albert B. Franklin, Inc., 25 Haverill St., Boston, are engineers.

Mass., Wakefield—Town, Morrison Merrill, Supt. of Water Dept., plans a waterworks system including fifteen driven wells and pumping station. Weston & Sampson, 14 Beacon St., Boston, are engineers.

Mass., Taunton—Commonwealth of Massachusetts, Dpt. of Mental Diseases, will soon award contract for improvements to boiler room including two 350 hp. water tube boilers, stokers, chimney, etc., Estimated cost $45,000. Charles T. Main, Inc., 201 Devonshire St., Boston, are engineers. Bids received Oct. 13.

Neb., North Bend—City awarded contract for tubular well and 350 g.p.m. deep well turbine pump and motor to Layne Western Co., 507 Mutual Bldg., Kansas City, Mo., also pump house to E. Eskildsen, North Bend, in connection with waterworks improvements. Estimated total cost $16,811.

N. Y., Syracuse—Syracuse Lighting Co., Inc., 421 South Warren St., awarded contract for third unit of service center at Erie Blvd. and Franklin St. to Fred. T. Ley & Co., 1215 Main St., Springfield, Mass. Estimated cost $400,000.

O., Findlay—City awarded contract for the construction of a sewage treatment plant, activated sludge type to A. L. Bentley & Sons, Belmont Ave., Toledo. $220,000. Equipment including pumps, motors, etc., will be purchased later.

Okla., Fort Sill—Constructing Quartermaster, will receive bids until Oct. 30 for the construction of an air corps hangar with annexes and boiler house annex. Appropriation $55,000.

Pa., McKeesport—James V. Balsamo, 433 5th Ave., is receiving bids for first unit of market building, 1 and 2 story, 110 x 195 ft. including temporary heating, refrigerating and climatic control at Sinclair St. and 5th Ave. Courtney L. Whittaker, Dravosburg, is architect.

Pa., Munhall—Borough of Munhall, L. Y. Woodward, Secy., Municipal Bldg., will soon award contract for waterworks improvements including pumping station, receiving well and building, pumps, motors, electrical equipment, etc. Estimated cost $75,000. F. B. Shafer, Municipal Bldg., is engineer.

Pa., Richeyville—Jones & Laughlin Steel Co., awarded contract for the construction of a sewage disposal plant including 1 story, 10 x 12 ft. pump house, 18 x 24 ft. settling tank and 55 x 100 ft. filter bed between Bellville and Centerville Sts. to Harris Construction Co., California, Pa.

S. D., Rapid City—Board of City Commissioners, City Hall, will receive bids until November 12 for a sewage treatment works including sludge pumping station, etc. Albert A. Chenoweth, Alex Johnson Hotel, is engineer.

Tenn., Murfreesboro—Board of Education, Nashville, awarded contract for the construction of a heating plant at State Normal School to Foster & Creighton, Fourth and First Bldg., Nashville.

Texas—West Texas Utilities Co., Abilene, acquired plant from private owners and plans 9 miles of 12 kv. transmissoin line from Chillicothe to Odell, also erection and equipping of sub-station at Odell.

Utah, Murray—City awarded contract for two 725 hp. impulse water wheels, to S. Morgan Smith Co., Salt Lake City, and two 625 kva. generators to Westinghouse Electric & Mfg. Co., McCormick Bldg., Salt Lake City, in connection with municipal hydro-electric power plant.

Wis., Baldwin—American Telephone & Telegraph Co., 311 West Washington St., Chicago, Ill., is having plans prepared for a 1 story, 50 x 50 ft. repeater station here. Estimated cost $40,000. Private plans.

Wis., Green Bay—Atlas Warehouse & Cold Storage Co., E. R. Fisher, Mgr., awarded contract for the construction of a 4 story 50 x 90 ft. cold storage warehouse to Jacob C. Basten, 1857 Willow St., Green Bay. Estimated cost $40,000.

Wis., Oconto—Common Council authorized purchase of water plant and will electrify entire plant and install new equipment. Estimated cost $60,000. Engineer not selected.

Que., Three Rivers—City Gas & Electric Corp., Quebec City, plans the construction of a gas plant here. Initial cost $500,000.

Equipment Wanted

Electric Light Plant Equipment — Richmond, Ind.—City appropriated $400,000 to purchase equipment for electric light plant including 15,000 kw. turbine with equipment, etc.

Meter, Controller, Pump, Motor and Control Gear—Christchurch, N. Z.—City Clerk, will receive bids until Nov. 12 for supply of Venturi meter and automatic controller, also pump, motor and control gear complete.

Pumps—Detroit Lakes, Minn.—City, E. J. Bestick, Clk., will receive bids until Oct. 26 for furnishing and installing three horizontal centrifugal pumps.

Sub-stations—Wellington, N. Z.—New Zealand Government Railways will receive bids until Feb. 29, 1932, for supply of three complete automatic railway sub-stations.

Industrial Projects

Calif., Long Beach—Fields Chemical Corp., Ltd., c/o R. D. Van Alstine, 410 East 9th St., Engr., is having plans prepared for a chemical plant including administration building, laboratory building and pump houses, etc., on Cherry Ave. Estimated cost $50,000.

Calif., San Francisco—California Carbonic Ice Mfg. Co., c/o C. A. Winder, 200 Bush St., Engr., preparing plans for a plant for the manufacture of ice from gases of sub-station stacks at 23rd and Illinois Sts. Estimated cost $250,000.

Calif., Vernon—Stauffer Chemical Co., of San Francisco, 624 California St., San Francisco awarded contract for the design and construction of two additional plant buildings here, 88 x 140 and 36 x 60 ft. to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $50,000.

Ind., Columbia City—Columbia City Woolen Mills, awarded contract for a mill to W. A. Sheets, 315 Cal-Wayne Bldg., Fort Wayne. Estimated cost $40,000.

Ind., Indianapolis—Real Silk Hosiery Co., 514 North Davidson St., awarded contract for the construction of a hosiery mill to Mead Construction Co., 1027 Lemeke Bldg. Estimated cost $40,000.

Md., Baltimore—R. H. Bozman & Bros., Inc., 1046-1054 Granby St., manufacturers of refrigerators, display cases, etc., will build a 1 story addition to plant.

N. J., Millville—Millville Hosiery Co., plans a 1 story, 107 x 122 ft. hosiery mill. Norman Hulme, 1524 Chestnut St., Philadelphia, Pa., is architect.

N. J., Raritan—H. Bulkin, North Bridge St., Somerville, is receiving bids for a 1 story, 60 x 160 ft. factory here. Estimated cost $40,000. P. C. Van Nuys, 1 West Main St., Somerville, is architect.

O., Cleveland—Di-Nock Mfg. Co., Keith E. Weigle, Pres., 875 East 140th St., manufacturers of decalcomania materials, plans the construction of a factory. Estimated cost $50,000. Architect not selected.

O., Youngstown—Youngstown Sheet & Tube Co., Stambaugh Bldg., plans the construction of an electric weld pipe mill. Estimated cost $1,500,000. Private plans.

Tex., Lampasas—Fort Worth Poultry & Egg Co., 719 East 9th St., Fort Worth, is having preliminary plans prepared for a 1 story, 40 x 120 ft. produce plant, including refrigeration room here. Private plans.

Tex., Laredo—Pecan Growers' Association, H. E. Hutches, Rep., Broadway Ave., San Antonio, plans the construction of a 1 and 2 story pecan plant including warehouse, refrigeration plant, etc., here. Private plans.

W. Va., Newell—Edwin M. Knowles China Co., awarded contract for a 1 story factory to house new tunnel kiln now under construction to Joseph Finley Co., Chester. Estimated cost $50,000.

Wis., Baldwin—Western Cable & Electric Co., G. Hansen, Mgr., plans the construction of a factory. Estimated cost $40,000. Architect not selected.

Wis., DePere—DePere Paper & Mfg. Co., c/o M. Miller, Pres., plans to rebuild paper mill factory destroyed by fire. Estimated cost $50,000. Architect not selected.